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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

# MINERAL RESOURCES
OF THE
# UNITED STATES

CALENDAR YEAR
1907

## PART II—NONMETALLIC PRODUCTS

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# COAL.

By **Edward W. Parker.**

## INTRODUCTION.

The record made in the coal-mining industry of the United States in 1907 was one of unprecedented tonnage, exceptionally high prices, and general industrial peace. The year was, in fact, one of the most satisfactory, from the producers' standpoint, in the history of the industry. Not only was the previous record-breaking production of 1906 (414,157,278 short tons) exceeded by nearly 16 per cent, but it may be stated confidently that had it not been for the depressed condition of the iron and steel trade which followed the financial flurry in October, the coal production in 1907 would have exceeded a total of half a billion short tons, and the value of the product would probably have exceeded $650,000,000. As it was, the value of the coal product of 1907 exceeded by 68 per cent the value of the total mineral product of the United States in 1880, and was nearly equal to the total mineral product of the country in 1897, only ten years before. The total value of the coal product of the United States at the mines, in 1907, was nearly $615,000,000, while the value of the entire mineral product of the United States in 1897 was $647,000,000, or only $32,000,000 more than the value of the coal produced in this country last year. The increase in 1907 over 1906 was nearly 10 per cent greater than the total coal production of the country in 1877, thirty years before.

The combined production of anthracite and bituminous coal in the United States in 1907 was a little over 480,360,000 short tons.

With an average of 30 cars of coal to the train, and of 50 tons to the car, the number of trains required to transport this product was 320,300 and the combined length of these trains would extend two and two-thirds times around the world at the equator. The hole left in the ground by the extraction of this fuel is equal to 17,585,000,000 cubic feet, and if the entire quantity of coal extracted were built into one cube, it would have the dimensions of 2,605 feet, or nearly half a mile on each edge. A rectangular column with a 1,000-foot base to represent the coal production of the United States in 1907 would extend nearly 3.4 miles into the air.

Some idea of the growth of the coal-mining industry within the last quarter of a century is shown by the fact that in 1907 the production was considerably more than double that of 1898, more than three times that of 1890, more than four times that of 1886, and considerably more than five times that of 1881.

The statistics presented in the following pages, which consider primarily the total quantity and value of the coal produced in 1907, in comparison with previous years, include also statements regarding the labor employed, the average number of days worked, the length of the working days, the production per man, the use of mining machines and the tonnage produced by them, the casualties reported by mine inspectors, and other matters of interest connected with the mining and marketing of coal. A special feature of the present report is a map of the coal fields of the United States prepared by Mr. Marius R. Campbell, of the United States Geological Survey, with a statement of the areas and estimated original content of coal within these fields; also a statement of the production in each field in 1907 and the estimated exhaustion represented by the total production to the close of that year.

## ACKNOWLEDGMENTS.

The statistics contained in these reports could not be secured in their completeness without the good will and disinterested cooperation of the individual coal-mine operators and the officials of corporations engaged in the industry. The writer desires to express his sincere appreciation of the assistance received from these sources. Acknowledgments are also due to the secretaries of boards of trade and to other local authorities for contributions to the portion of this report included under the caption of "Coal trade review." Recognition of these by name is given in connection with their contributions. The report on the production of Pennsylvania anthracite has been, as for several years past, prepared by Mr. William W. Ruley, chief of the bureau of anthracite statistics, in Philadelphia.

## UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the short ton of 2,000 pounds, although it is necessary in a few instances to use the long ton. All of the anthracite product is mined and sold on the basis of the long ton of 2,240 pounds, and the laws of Maryland require the use of the long ton in that State. Hence when considering the production of Pennsylvania anthracite the long ton is used, and this unit is also employed in the table showing the shipments of bituminous coal from the Cumberland region. The long ton is also used in the statistics of imports and exports. In all other cases where the production is reported in long tons the figures have been reduced to short tons, and unless otherwise expressly stated the short ton is meant when any quantity is expressed in the text.

## PRODUCTION.

Total production in 1907, 480,363,424 short tons; spot value, $614,798,898.

*Pennsylvania anthracite.*—Total production in 1907, 76,432,421 long tons (equivalent to 85,604,312 short tons); spot value, $163,584,056.

*Bituminous and lignite.*—Total production in 1907, 394,759,112 short tons; spot value, $451,214,842.

In addition to the unprecedented demand which resulted in the record breaking output of coal in the United States in 1907, the year was one of exceptional peace in the coal-mining regions. When after the ten weeks' suspension of mining, beginning on April 1, 1906, the wage scales in the "organized" States were signed, the agreements were made to cover a period of two years, or until March 31, 1909. There were a few instances of labor disaffection in 1907, but these were for the most part of short duration, and the amount of time lost was not sufficient to affect the total production. Taken as a whole, the year 1907 was one of the most prosperous years in the history of the coal-mining industry.

Compared with 1906, when the total production amounted to 414,157,278 short tons, valued at $513,079,809, the output in 1907 showed an increase of 66,206,146 short tons, or 15.99 per cent in quantity, and of $101,719,089, or 19.83 per cent in value. Of this increase, 12,787,411 long tons, or 14,321,901 short tons, were in the production of Pennsylvania anthracite, and 51,884,245 tons in the production of bituminous, semibituminous, subbituminous, lignite, and scattering lots of anthracite. The value of the Pennsylvania anthracite production increased $31,666,362, and the total value of the other grades of coal showed an increase of $70,052,727. It is worthy of note that of the 31 States and Territories of the Union in which coal was produced during 1907, there were only 2 which did not participate in the general increased production. The two exceptions were California and Oregon, both unimportant as coal-producing States, both on the Pacific coast, and the decrease in both States being due to the same cause—the largely increased production of fuel oil in California and its use for railroad and manufacturing purposes. The percentages of increase in the various States ranged from 1.79 in Maryland to 51 in Michigan, and in only three cases where the production increased was the percentage of increase in value less than the percentage of increase in quantity. These three exceptions were Alabama Illinois, and Indiana. The largest increase in quantity was in the production of Pennsylvania bituminous coal, which showed an increase of 20,849,971 short tons, with a gain of $25,373,375 in value. Pennsylvania anthracite showed the next largest gain in quantity, the increase in this output being 14,321,901 short tons, while the gain in value exceeded that of Pennsylvania bituminous coal, amounting to $31,666,362. The total increase in Pennsylvania's production was 35,171,872 short tons, while the aggregate value of Pennsylvania's production showed a gain of $57,039,737. Illinois, the second State in coal-producing importance, was second in increased production, with a gain of 9,837,042 short tons in quantity and $9,924,320 in value. West Virginia, the third in producing importance, was third in increased production, with a gain of 4,801,233 short tons in quantity and $6,794,691 in value. Ohio, fourth in rank, was fourth in amount of increased output, showing a gain of 4,410,779 short tons and $4,978,166. The total increase in the production of anthracite and bituminous coal in the United States in 1907 was about 10 per cent larger than the total coal production in 1877, 30 years before.

A part of the increased production in 1907, and particularly in that of Pennsylvania anthracite, was undoubtedly due to the shortage in stocks created by the ten weeks' suspension of mining in the anthracite fields of Pennsylvania and in the organized bituminous coal-producing States which began on April 1, 1906, pending the adjustment of the wage-scale controversy, the increased production in 1906, which followed the resumption of work, not having been sufficient to fill requirements and also replenish stocks. The financial depression, which began in the middle of October and continued during the rest of the year, was seriously felt in the coal-mining industry, especially in the Eastern States, where a considerable percentage of the product is made into coke and the demand for which fell off rapidly in sympathy with the shutting down of a large number of blast furnaces and rolling mills.

The unprecedented demand for coal which obtained during the first 9 months of the year exceeded the ability of the railroad companies to handle the product, and there was the usual complaint of shortage of cars which had been made during the last few years. There was also a great demand for, and high prices were paid to, labor in other lines of industry, and operators were unable to secure miners in sufficient numbers to fill orders. Wages were unusually high. All of these conditions tended toward the advancing prices which were general throughout the United States. The average price per ton for bituminous coal and lignite advanced from $1.11 in 1906 to $1.14 in 1907. The average price of anthracite at the mines in Pennsylvania advanced from $2.30 to $2.35 per long ton. In obtaining these average prices it should be remembered that the average price of bituminous coal is based upon all of the coal sold or used at the mines, either for coke making or in the operation of the properties. Only the bituminous coal actually wasted is excluded from the valuation, and this is also not included in the statement of production. The coal used in the mines of the anthracite region of Pennsylvania is composed principally of culm, which until quite recently, except for that used in the operation of the mines, has been thrown upon the dumps and wasted. In recent years, however, with the establishment of washeries for the saving of the small sizes of coal produced, and also for the recovery from the culm banks of that previously wasted, places a marketable value upon this formerly disregarded product. An arbitrary value of 20 cents per long ton has been placed upon the colliery consumption of anthracite.

A considerable portion of both the anthracite and bituminous coal is sold at much less than the cost of production. The public press is apt to note critically the wide discrepancy between the prices shown by these averages and those which the public is obliged to pay for its fuel, forgetting or neglecting the fact that all of the profits on mining operations in the anthracite region have to be made on sizes above pea coal, which represent only a little more than 60 per cent of the total production. All of the buckwheat, rice, barley, and other sizes below pea coal shipped from the anthracite region, which are used entirely for steam purposes, are sold at prices considerably below the actual cost of production. In the bituminous regions a large portion of the coal is marketed as screened coal and in many cases the sizes below nut are sold at less than cost.

An interesting fact presented in the statistics of the production of coal in the United States is that in each decade the output has been practically doubled. Up to the close of 1865 the total production had amounted to 284,890,055 tons. In the decade from 1866 to 1875, inclusive, the production amounted to 419,425,104 tons, making the total production up to the close of 1875, 704,315,159 tons. In the following decade, from 1876 to 1885, inclusive, the production amounted to 847,760,319 tons, something more than double the total production up to the beginning of that decade. At the close of 1885 the total production amounted to 1,552,075,478 tons, and the production for the 10 years ending with 1895 was 1,586,098,641 tons, and the total production to the close of 1895 amounted to 3,138,174,119 short tons. In the decade ending December 31,1905, the total production amounted to 2,832,402,746 short tons and the grand total from the beginning of coal mining amounted to 5,970,576,865 short tons. The average annual production from 1896 to 1905 was 283,240,275 short tons, compared with which the average production in 1906 and 1907 (447,260,351 short tons) shows an increase of 164,020,076 tons, or 58 per cent.

This great increase in the production of coal, when considered with the increase in the population, furnishes some further interesting comparisons. Going back for a period of a little over 50 years, or to the middle of the last century, and comparing the statistics of coal production with the increased population, it is found that in 1850, according to the United States census for that year, the production of coal amounted to 6,445,681 tons, when the population of the country amounted to 23,191,876 persons. The per capita production of coal in that year is thus seen to have been 0.278 ton. In 1860, or 10 years later, the population was 31,443,321 persons, and the coal production amounted to 16,139,736 tons, or an average of 0.514 ton per person. At the census of 1870 the population of the United States amounted to 38,558,371; the coal production in that year amounted to 36,806,560 short tons, a per capita average of 0.96 ton. Ten years later, when the population was 50,189,209, the coal output amounted to 76,157,944 short tons, or 1.52 tons per capita. In 1890 the population had grown to 63,069,756, an increase of 25 per cent over 1880, while the coal production had grown to 157,770,963 short tons, or a per capita output of 2.52 tons. At the taking of the Twelfth Census, in 1900, the increase in population amounted to 22 per cent, the total number of persons reported being 76,303,387, while more than 70 per cent had been added to the coal production, with a total of 269,684,027 short tons, or an average of 3.53 tons for each inhabitant. In other words, while the population from 1850 to 1900 showed an increase of 230 per cent the production of coal increased 4,084 per cent. The Director of the Bureau of the Census, Hon. S. N. D. North, estimates the population of the United States on June 1, 1907, at about 85,500,000 persons, making the per capita production in that year 5.6 tons; that is, in less than 60 years the per capita production of coal in this country has increased from a little more than a quarter of a ton to 5½ tons. It is true that in the earlier years the proportion of wood used for fuel was larger than it is to-day, but the actual consumption of wood at this time is little, if any, less than it was 50 years ago, and is probably greater. It must also be remembered that in addition to the great increase in the consumption of coal per head of population there has been a great increase in the use of oil for fuel purposes, while natural gas still remains an important factor in this regard.

The total number of men employed in the coal mines of the United States in 1907 was 680,492, against 640,780 in 1906 and 626,035 in 1905. Of the total number of men who were employed in 1907, 167,234 were employed in the anthracite mines of Pennsylvania, while the bituminous and lignite mines gave employment to 513,258 men. In 1906 the anthracite mines gave employment to 162,355 men and in 1905 to 165,406 men. The bituminous workers numbered 478,425 in 1906 and 460,629 in 1905. The average number of days worked in the anthracite region in 1907 was 220, against an average of 195 in 1906 and 215 in 1905. The bituminous mines worked an average of 234 days in 1907, 213 days in 1906, and 211 days in 1905. The average production for each employee in the anthracite region of Pennsylvania in 1907 was 512 tons, against 439 tons in 1906 and 470 in 1905. The average production for each employee in the bituminous mines in 1907 was 769 tons, against 717 tons in 1906 and 684 tons in 1905. The average daily production per man in the anthracite region, which decreased from 2.41 tons in 1903 to 2.35 tons in 1904 and to 2.18 tons in 1905, increased to 2.25 tons in 1906 and to 2.33 tons in 1907. The average production per day by each employee in the bituminous mines, which increased steadily from 3.02 in 1903 to 3.15 in 1904 and to 3.24 in 1905 and 3.36 in 1906, fell off to 3.29 in 1907.

The statistics relative to the use of machines in the mining of bituminous coal in the United States, the details of which are to be found in subsequent pages of this report, show that in 1907 the total quantity of coal mined by the use of machines was 138,547,823 short tons, or 35.71 per cent of the total production in the States where mining machines were used; against 118,847,527 short tons, or 35.1 per cent of the total in 1906, and 103,396,452 short tons, or 33.67 per cent of the total in 1905. The total number of mining machines in use increased from 9,184 in 1905 to 10,212 in 1906 and 11,144 in 1907. The average production for each machine in use in 1907 was 12,381 short tons against 11,638 short tons in 1906, and 11,258 tons in 1905, from which it appears that the average annual tonnage which was won by machines is something over 11,000 tons. Of the 11,144 machines used in 1907, 6,227 were of the pick or puncher type, 4,652 were chain-breast, and 265 were long-wall machines.

Pennsylvania, which leads in the production of bituminous coal, leads also in the number of machines in use and in the total machine-mined production, there having been 4,940 mining machines employed in the bituminous coal mines of Pennsylvania, and 60,771,157 tons of machine-mined bituminous coal in that State in 1907. Ohio leads in the percentage of coal mined by machines and was second in the total quantity of machine-mined coal, although West Virginia exceeded Ohio in the number of machines in use. Ohio had in 1907 1,328 machines at work, with a machine-mined product of 24,843,616 short tons, while West Virginia employed 1,533 machines and had a machine-mined product in 1907 of 17,627,925 tons. Illinois had 1,080 machines in use in 1907, with a machine-mined product of 15,134,401 tons.

In addition to the unprecedented production and the higher prices obtained in 1907, the year was remarkable for the reign of comparative peace throughout the coal-mining regions. There were really no protracted strikes during the year, if there may be excepted from this statement an idleness of 45 days at one mine in Alabama in which 80 men were employed. There were fewer men on strike in 1907 than in any year since 1901, and the amount of time lost through labor disaffections last year was the smallest in a decade. The total number of men idle by reason of strikes was 32,540, who were idle an average of 14 days each. Outside of the exception in Alabama, previously referred to, the greatest amount of time lost was in Kentucky, where 1,325 men were idle for an average of 41 days, and in Arkansas, where 1,185 men were idle for an average of 30 days. The principal cause of the labor troubles was the inability of the operators to secure currency for pay rolls after the panic began in October, and the refusal of the men to accept payment of their wages in anything but cash. In 1906 there were 372,343 men idle by reason of strikes, but because of the "suspension" on April 1 the average time lost by each man was 51.5 days. The total number of working days lost in 1906 was 19,201,348. The total number of working days lost in 1907 was 462,392.

The United States Geological Survey makes no attempt to collect direct the statistics covering the fatal and nonfatal accidents occurring in the mines of the country. The statistics presented in the subsequent pages are compiled from the reports received from the mine inspectors or other State officials having in charge the administration of State inspection laws. Casualty statistics are therefore incomplete to the extent represented by those States in which there are no mine inspection laws. These exceptions are, however, of comparative unimportance as practically all of the important coal-mining States now have inspection laws, and the officials in charge of their execution compile the statistics of accidents in each year. In some cases these are for the fiscal year, but in most cases they cover calendar years and coincide with the period for which the statistics of production are given in this report. The States from which the accident statistics are reported contribute over 90 per cent of the total coal product of the United States. In the record of fatal and nonfatal accidents the year 1907 was the worst in the history of coal production in this country. During December there were four separate disasters, all in the Appalachian bituminous coal field, and each attended with the sacrifice of many lives. The most serious of these disasters was that at Monongah, West Virginia, and made that State responsible for more than 50 per cent of the deaths due to gas and dust explosions in 1907. Of the total number of men killed in the 18 States from which reports were received in 1907, there were 3,125 men killed and 5,316 injured in the coal mines during that year, whereas in 1906 21 States reported a total of 2,092 fatal and 4,800 nonfatal accidents. The fatalities of 1907 exceeded those of 1906 by almost exactly 50 per cent.

Practically the entire output of both anthracite and bituminous coal in the United States is consumed within the country. The total exports of coal in 1907 amounted to 14,724,358 short tons, which, deducted from the production of 480,363,424 tons, shows a consumption of coal of domestic production amounting to 465,639,066 short tons. If to this are added the imports, which in 1907 amounted to 2,367,241 short tons, the total consumption of coal in the United States in 1907 (considering as negligible the stocks on hand at the beginning and end of the year) is shown to have been 468,006,307 tons, which is equivalent to nearly 98 per cent of the domestic production.

Most of the coal imported into the United States is classed as bituminous or shale, only a comparatively small quantity of anthracite being brought into the country. The imports of bituminous coal are principally to points on the Pacific coast and to the port of Boston, where considerable quantities of bituminous slack are imported from Canada and used at the Otto-Hoffmann coke ovens at Everett, near Boston. The exports of both anthracite and bituminous coal are principally to Canada.

In considering the coal product of the United States these reports include not only the coal marketed, either by shipment to distant points or sold locally, but that consumed by mine employees and by the mine owners in the operation of the collieries. The latter factor is usually considered and reported as colliery consumption. There are occasional exceptions in the bituminous fields, where the operators, who use only slack, an otherwise waste product, do not report this item in their statement of production and do not deem it of any value; it is not considered as a portion of the mine product, nor is the miner paid for it in wages. Such exceptions are few and the quantity is negligible. The quantity of coal consumed in the manufacture of coke is also considered in this report.

The quantity of coal consumed in the manufacture of coke at the mines in 1907 was 50,289,822 short tons, as compared with 46,156,301 short tons in 1906, an increase of 4,133,521 short tons, or 9 per cent, as compared with an increase of 16 per cent in the total production. The coal shipped to market and used in the manufacture of coke, and sold locally (which is considered a marketable product) amounted in 1907 to 462,802,051 short tons, compared with 399,323,294 short tons in 1906, and 378,680,462 short tons in 1905. The colliery consumption in the anthracite region, which consists practically altogether of culm, averages from 8 to 10 per cent of the total anthracite output. In 1907, out of a total production of 85,604,312 short tons of anthracite, 8,351,623 tons were used at the mines for steam and heat. The colliery consumption of bituminous coal amounts to between 2 and 3 per cent of the total production, and in 1907, out of a total of 394,759,112 tons of bituminous coal mined, 9,209,750 tons were used in the operation of the properties.

The statistics of the production of coal in the United States in 1906 and 1907, by States, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of the United States in 1906, by States and Territories, in short tons.*

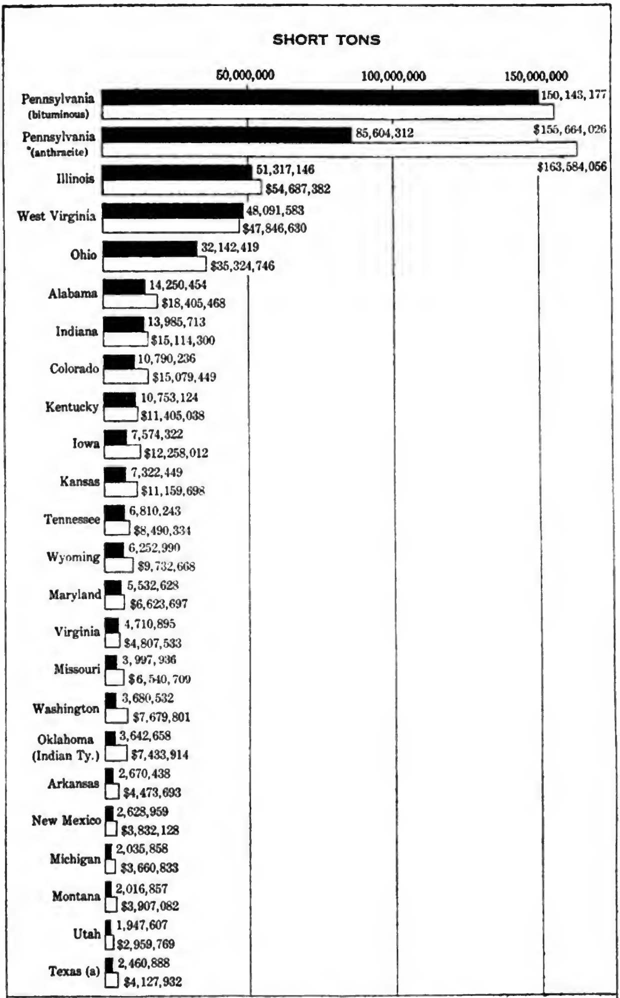
| State or Territory. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Alabama | 9,409,005 | 131,881 | 446,712 | 3,120,365 | 13,107,963 | $17,514,786 | $1.34 | 237 | 20,555 |
| Arkansas | 1,792,242 | 14,362 | 57,664 | .............. | 1,864,268 | 3,000,339 | 1.61 | 165 | 4,298 |
| California and Alaska | 11,878 | 15,942 | 3,011 | .............. | 30,831 | 78,684 | 2.55 | 253 | 56 |
| Colorado | 7,697,481 | 202,579 | 252,115 | 1,959,043 | 10,111,218 | 12,735,616 | 1.26 | 268 | 11,368 |
| Georgia | 194,881 | 850 | 8,324 | 128,052 | 332,107 | 424,004 | 1.28 | 279 | 737 |
| Idaho[a] | .............. | 6,165 | .............. | .............. | 6,165 | 24,238 | 3.93 | 157 | 25 |
| Illinois | 37,273,693 | 2,778,141 | 1,418,197 | 10,073 | 41,480,104 | 44,763,062 | 1.08 | 192 | 61,988 |
| Indiana | 11,106,753 | 647,432 | 338,375 | .............. | 12,092,560 | 13,116,261 | 1.08 | 175 | 20,970 |
| Indian Territory | 2,629,731 | 38,535 | 122,299 | 69,635 | 2,860,200 | 5,482,366 | 1.92 | 166 | 8,251 |
| Iowa | 6,461,208 | 633,652 | 171,364 | .............. | 7,266,224 | 11,619,455 | 1.60 | 224 | 15,260 |
| Kansas | 5,547,213 | 313,150 | 163,241 | 1,171 | 6,024,775 | 8,979,553 | 1.49 | 165 | 14,355 |
| Kentucky | 8,829,501 | 441,729 | 246,894 | 135,523 | 9,653,647 | 9,809,938 | 1.02 | 212 | 15,272 |
| Maryland | 5,331,321 | 50,306 | 53.826 | .............. | 5,435,453 | 6,474,793 | 1.19 | 250 | 6,438 |
| Michigan | 1,189,972 | 106,538 | 49 828 | .............. | 1,346,338 | 2,427,404 | 1.80 | 173 | 3,971 |
| Missouri | 3,300,867 | 386,067 | 71,074 | .............. | 3,758,008 | 6,118,733 | 1.63 | 185 | 9,557 |
| Montana | 1,621,291 | 65,858 | 73,727 | 69,045 | 1,829,921 | 3,240,357 | 1.77 | 243 | 2,394 |
| New Mexico | 1,605,798 | 35,102 | 34,706 | 289.107 | 1,964,713 | 2,638,986 | 1.34 | 242 | 2,070 |
| North Dakota | 189,739 | 111,638 | 4.312 | .............. | 305,689 | 451,382 | 1.54 | 209 | 488 |
| Ohio | 25,915,172 | 1,392,350 | 422,094 | 2,024 | 27,731,640 | 30,346,580 | 1.09 | 167 | 45,438 |
| Oregon | 55,232 | 7,398 | 17,101 | .............. | 79,731 | 212,338 | 2.66 | 224 | 209 |
| Pennsylvania | 93,904,804 | 1,791,889 | 2,570,319 | 31,026,194 | 129,293,206 | 130,290,651 | 1.00 | 231 | 152,099 |
| Tennessee | 5,208,054 | 87,335 | 118,051 | 845,835 | 6,259,275 | 7,667,415 | 1.22 | 229 | 11,452 |
| Texas | 1,264,218 | 22,386 | 26,269 | .............. | 1,312,873 | 2,178,901 | 1.66 | 227 | 3,048 |
| Utah | 1,142,127 | 21,004 | 57,012 | 552,408 | 1,772,551 | 2,408,381 | 1.36 | 288 | 1,572 |
| Virginia | 1,940,524 | 50,275 | 91,666 | 2,172,414 | 4,254,879 | 4,183,991 | .98 | 250 | 5,131 |
| Washington | 3,008,148 | 61,146 | 110,669 | 96,221 | 3,276,184 | 5,908,434 | 1.80 | 266 | 4,529 |
| West Virginia | 36,389,483 | 633,487 | 589,844 | 5,677,536 | 43,290,350 | 41,051,939 | .95 | 220 | 50,960 |
| Wyoming | 5,801,623 | 59,656 | 271,060 | 1.655 | 6,133,994 | 8,013,528 | 1.31 | 281 | 5,934 |
| Total bituminous | 278,821,959 | 10,106,853 | 7,789,754 | 46,156,301 | 342,874,867 | 381,162,115 | 1.11 | 213 | 478,425 |
| Pennsylvania anthracite | 62,704,796 | 1,533.385 | 7.044.230 | .............. | 71,282,411 | 131,917,694 | 1.85 | 195 | 162,355 |
| Grand total | 341,526,755 | 11,640,238 | 14,833.984 | 46,156,301 | 414,157,278 | 513,079,809 | 1.24 | 209 | 640,780 |

[a] Includes production of Nevada.

*Coal production of the United States in 1907, by States and Territories, in short tons.*

| State or Territory. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Alabama | 11,144,452 | 216,547 | 522,793 | 2,366,662 | 14,250,454 | $18,405,468 | $1.29 | 242 | 21,388 |
| Arkansas | 2,556,226 | 22,715 | 91,497 | .............. | 2,670,438 | 4,473,693 | 1.68 | 190 | 5,085 |
| California and Alaska | 14,265 | 6,014 | 3,810 | .............. | 24,089 | 91,813 | 3.81 | 187 | 76 |
| Colorado | 8,409,624 | 258,069 | 296,279 | 1,826,264 | 10,790,236 | 15,079,449 | 1.40 | 258 | 14,223 |
| Georgia | 204,890 | 5,780 | 10,700 | 141,031 | 362,401 | 499,686 | 1.38 | 262 | 808 |
| Idaho[a] | 300 | 7,278 | 10 | .............. | 7,588 | 31,119 | 4.10 | 121 | 22 |
| Illinois | 46,908,118 | 2,775,321 | 1,625,112 | 8,595 | 51,317,146 | 54,687,382 | 1.07 | 218 | 65,581 |
| Indiana | 12,887,937 | 755,061 | 342,715 | .............. | 13,985,713 | 15,114,300 | 1.08 | 197 | 21,022 |
| Iowa | 6,774,144 | 617,771 | 182,407 | .............. | 7,574,322 | 12,258,012 | 1.62 | 230 | 15,585 |
| Kansas | 6,957,953 | 172,859 | 191,637 | .............. | 7,322,449 | 11,159,698 | 1.52 | 225 | 12,439 |
| Kentucky | 9,911,715 | 476,739 | 254,679 | 109,991 | 10,753,124 | 11,405,038 | 1.06 | 210 | 16,971 |
| Maryland | 5,427,882 | 48,461 | 56,285 | .............. | 5,532,628 | 6,623,697 | 1.20 | 263 | 5,880 |
| Michigan | 1,792,598 | 129,434 | 113,826 | .............. | 2,035,858 | 3,660,833 | 1.80 | 234 | 3,982 |
| Missouri | 3,495,133 | 437,072 | 65,731 | .............. | 3,997,936 | 6,540,709 | 1.64 | 214 | 8,448 |
| Montana | 1,793,475 | 73,609 | 89,534 | 60,239 | 2,016,857 | 3,907,082 | 1.94 | 268 | 2,735 |
| New Mexico | 2,038,475 | 36,205 | 56,000 | 498,279 | 2,628,959 | 3,832,128 | 1.46 | 269 | 2,970 |
| North Dakota | 218,308 | 118,102 | 11,350 | .............. | 347,760 | 560,199 | 1.61 | 223 | 562 |
| Ohio | 29,738,788 | 1,859,906 | 542,425 | 1,300 | 32,142,419 | 35,324,746 | 1.10 | 199 | 46,833 |
| Oklahoma (Indian Territory) | 3,381,420 | 58,882 | 161,957 | 40,399 | 3,642,658 | 7,433,914 | 2.04 | 216 | 8,398 |
| Oregon | 39,095 | 14,840 | 17,046 | .............. | 70,981 | 166,304 | 2.34 | 231 | 184 |
| Pennsylvania | 110,009,673 | 1,941,132 | 3,040,183 | 35,152,189 | 150,143,177 | 155,664,026 | 1.04 | 255 | 163,206 |
| Tennessee | 5,741,988 | 135,000 | 129,653 | 803,602 | 6,810,243 | 8,490,334 | 1.25 | 232 | 12,052 |
| Texas | 1,584,576 | 27,118 | 36,375 | .............. | 1,648,069 | 2,778,811 | 1.69 | 244 | 4,227 |
| Utah | 1,287,649 | 22,149 | 65,368 | 572,441 | 1,947,607 | 2,959,769 | 1.52 | 258 | 2,203 |
| Virginia | 2,359,806 | 78,704 | 96,653 | 2,175,732 | 4,710,895 | 4,807,533 | 1.02 | 241 | 6,670 |
| Washington | 3,365,097 | 90,762 | 134,265 | 90,408 | 3,680,532 | 7,679,801 | 2.09 | 273 | 5,945 |
| West Virginia | 39,942,715 | 932,652 | 773,526 | 6,442,690 | 48,091,583 | 47,846,630 | .99 | 230 | 59,029 |
| Wyoming | 5,881,055 | 74,001 | 297,934 | .............. | 6,252,990 | 9,732,668 | 1.56 | 275 | 6,645 |
| Total bituminous | 323,867,357 | 11,392,183 | 9,209,750 | 50,289,822 | 394,759,112 | 451,214,842 | 1.14 | 234 | 513,258 |
| Pennsylvania anthracite | 75,553,838 | 1,698,851 | 8,351,623 | .............. | 85,604,312 | 163,584,056 | 1.91 | 220 | 167,234 |
| Grand total | 399,421,195 | 13,091,034 | 17,561,373 | 50,289,822 | 480,363,424 | 614,798,898 | 1.28 | 231 | 680,492 |

[a] Includes the production of Nebraska and Nevada.



(a) Includes the production of Oregon, North Dakota, Georgia, Idaho, Nevada, Nebraska, California and Alaska

FIG. 1.—Production of coal in the United States in 1907, by States.

## PRODUCTION IN PREVIOUS YEARS.

In the following table is presented a statement of the quantity and value of the coal product of the United States during the last five years, by States, with the increases and decreases in 1907 as compared with 1906:

*Quantity and value of coal produced in the United States, 1903–1907, in short tons.*

| State or Territory. | 1903. | | 1904. | | 1905. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 11,654,324 | $14,246,798 | 11,262,046 | $13,480,111 | 11,866,069 | $14,387,721 |
| Arkansas | 2,229,172 | 3,360,831 | 2,009,451 | 3,102,660 | 1,934,673 | 2,880,738 |
| California and Alaska | 105,420 | 301,318 | 79,582 | 377,306 | 80,824 | 395,975 |
| Colorado | 7,423,602 | 9,150,943 | 6,658,355 | 8,751,821 | 8,826,429 | 10,810,978 |
| Georgia and North Carolina | 434,260 | 546,759 | 390,191 | 476,996 | 353,548 | 456,184 |
| Idaho | 4,250 | 13,250 | 3,480 | 13,730 | [a] 5,882 | [a] 17,846 |
| Illinois | 36,957,104 | 43,196,809 | 36,475,060 | 39,941,993 | 38,434,363 | 40,577,592 |
| Indiana | 10,794,692 | 13,244,817 | 10,842,189 | 12,004,300 | 11,895,252 | 12,492,255 |
| Indian Territory | 3,517,388 | 6,386,463 | 3,046,539 | 5,532,066 | 2,924,427 | 5,145,358 |
| Iowa | 6,419,811 | 10,563,910 | 6,519,933 | 10,504,406 | 6,798,609 | 10,586,381 |
| Kansas | 5,839,976 | 8,871,953 | 6,333,307 | 9,640,771 | 6,423,979 | 9,350,542 |
| Kentucky | 7,538,032 | 7,979,342 | 7,576,482 | 7,868,192 | 8,432,523 | 8,385,232 |
| Maryland | 4,846,165 | 7,189,784 | 4,813,622 | 5,729,085 | 5,108,539 | 5,831,760 |
| Michigan | 1,367,619 | 2,707,527 | 1,342,840 | 2,424,935 | 1,473,211 | 2,512,697 |
| Missouri | 4,238,586 | 6,834,297 | 4,168,308 | 6,801,751 | 3,983,378 | 6,291,661 |
| Montana | 1,488,810 | 2,440,846 | 1,358,919 | 2,194,548 | 1,643,832 | 2,823,350 |
| New Mexico | 1,541,781 | 2,105,785 | 1,452,325 | 1,904,499 | 1,649,933 | 2,190,231 |
| North Dakota | 278,645 | 418,005 | 271,928 | 389,052 | 317,542 | 424,778 |
| Ohio | 24,838,103 | 31,932,327 | 24,400,220 | 26,579,738 | 25,552,950 | 26,486,740 |
| Oregon | 91,144 | 221,031 | 111,540 | 243,588 | 109,641 | 282,495 |
| Pennsylvania: | | | | | | |
| Anthracite | 74,607,068 | 152,036,448 | 73,156,709 | 138,974,020 | 77,659,850 | 141,879,000 |
| Bituminous | 103,117,178 | 121,752,759 | 97,938,287 | 94,428,219 | 118,413,637 | 113,390,507 |
| Tennessee | 4,798,004 | 5,979,830 | 4,782,211 | 5,642,393 | 5,766,690 | 6,577,881 |
| Texas | 926,759 | 1,505,383 | 1,195,944 | 1,983,636 | 1,200,684 | 1,968,558 |
| Utah | 1,681,409 | 2,026,038 | 1,493,027 | 1,943,440 | 1,332,372 | 1,793,510 |
| Virginia | 3,451,307 | 3,302,149 | 3,410,914 | 2,921,911 | 4,275,271 | 3,777,325 |
| Washington | 3,193,273 | 5,380,679 | 3,137,681 | 5,120,931 | 2,864,926 | 5,141,258 |
| West Virginia | 29,337,241 | 34,297,019 | 32,406,752 | 28,647,014 | 37,791,580 | 32,341,790 |
| Wyoming | 4,635,293 | 5,731,281 | 5,178,556 | 6,747,909 | 5,602,021 | 7,336,951 |
| Total | 357,356,416 | 503,724,381 | 351,816,398 | 444,371,021 | 392,722,635 | 476,537,294 |

[a] Includes production of Nevada.

*Quantity and value of coal produced in the United States, 1903–1907, in short tons*—Continued.

| State or Territory. | 1906. | | 1907. | | Increase (+) or decrease (−). 1907. | | Percentage of increase or decrease, 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 13,107,963 | $17,514,786 | 14,250,454 | $18,405,468 | + 1,142,491 | + $890,682 | + 8.72 | + 5.09 |
| Arkansas | 1,864,268 | 3,000,339 | 2,670,438 | 4,473,693 | + 806,170 | + 1,473,354 | +43.30 | +49.11 |
| California and Alaska | 30,831 | 78,684 | 24,089 | 91,813 | − 6,742 | + 13,129 | −21.87 | +16.69 |
| Colorado | 10,111,218 | 12,735,616 | 10,790,236 | 15,079,449 | + 679,018 | + 2,343,833 | + 6.72 | +18.40 |
| Georgia and North Carolina | a332,107 | a424,004 | a362,401 | a499,686 | + 30,294 | + 75,682 | + 9.12 | +17.85 |
| Idaho | b6,165 | b24,238 | c7,588 | c31,119 | + 1,423 | + 6,881 | +23.08 | +28.39 |
| Illinois | 41,480,104 | 44,763,062 | 51,317,146 | 54,687,382 | + 9,837,042 | + 9,924,320 | +23.72 | +22.17 |
| Indiana | 12,092,560 | 13,116,261 | 13,985,713 | 15,114,300 | + 1,893,153 | + 1,998,039 | +15.66 | +15.23 |
| Iowa | 7,266,224 | 11,619,455 | 7,574,322 | 12,258,012 | + 308,098 | + 638,557 | + 4.24 | + 5.50 |
| Kansas | 6,024,775 | 8,979,553 | 7,322,449 | 11,159,698 | + 1,297,674 | + 2,180,145 | +21.53 | +24.28 |
| Kentucky | 9,653,647 | 9,809,938 | 10,753,124 | 11,405,038 | + 1,099,477 | + 1,595,100 | +11.39 | +16.26 |
| Maryland | 5,435,453 | 6,474,793 | 5,532,628 | 6,623,697 | + 97,175 | + 148,904 | + 1.79 | + 2.30 |
| Michigan | 1,346,338 | 2,427,404 | 2,035,858 | 3,660,833 | + 689,520 | + 1,233,429 | +51.00 | +51.00 |
| Missouri | 3,758,008 | 6,118,733 | 3,997,936 | 6,540,709 | + 239,928 | + 421,976 | + 6.38 | + 6.90 |
| Montana | 1,829,921 | 3,240,357 | 2,016,857 | 3,907,082 | + 186,936 | + 666,725 | +10.22 | +20.58 |
| New Mexico | 1,964,713 | 2,638,986 | 2,628,959 | 3,832,128 | + 664,246 | + 1,193,142 | +33.81 | +45.21 |
| North Dakota | 305,689 | 451,382 | 347,760 | 560,199 | + 42,071 | + 108,817 | +13.76 | +24.11 |
| Ohio | 27,731,640 | 30,346,580 | 32,142,419 | 35,324,746 | + 4,410,779 | + 4,978,166 | +15.91 | +16.40 |
| Oklahoma (Indian Territory) | 2,860,200 | 5,482,366 | 3,642,658 | 7,433,914 | + 782,458 | + 1,951,548 | +27.36 | +35.60 |
| Oregon | 79,731 | 212,338 | 70,981 | 166,304 | − 8,750 | − 46,034 | −10.97 | −21.68 |
| Pennsylvania: | | | | | | | | |
| Anthracite | 71,282,411 | 131,917,694 | 85,604,312 | 163,584,056 | +14,321,901 | +31,666,362 | +20.09 | +24.00 |
| Bituminous | 129,293,206 | 130,290,651 | 150,143,177 | 155,664,026 | +20,849,971 | +25,373,375 | +16.13 | +19.47 |
| Tennessee | 6,259,275 | 7,667,415 | 6,810,243 | 8,490,334 | + 550,968 | + 822,919 | + 8.80 | +10.73 |
| Texas | 1,312,873 | 2,178,901 | 1,648,069 | 2,778,811 | + 335,196 | + 599,910 | +25.53 | +27.53 |
| Utah | 1,772,551 | 2,408,381 | 1,947,607 | 2,959,769 | + 175,056 | + 551,388 | + 9.88 | +22.89 |
| Virginia | 4,254,879 | 4,183,991 | 4,710,895 | 4,807,533 | + 456,016 | + 623,542 | +10.72 | +14.90 |
| Washington | 3,276,184 | 5,908,434 | 3,680,532 | 7,679,801 | + 404,348 | + 1,771,367 | +12.34 | +29.98 |
| West Virginia | 43,290,350 | 41,051,939 | 48,091,583 | 47,846,630 | + 4,801,233 | + 6,794,691 | +11.09 | +16.55 |
| Wyoming | 6,133,994 | 8,013,528 | 6,252,990 | 9,732,668 | + 118,996 | + 1,719,140 | + 1.94 | +21.45 |
| Total | 414,157,278 | 513,079,809 | 480,363,424 | 614,798,898 | +66,206,146 | +101 719,089 | +15.99 | +19.83 |

[a] Georgia only.
[b] Includes production of Nevada.
[c] Includes production of Nebraska and Nevada.

One of the interesting features connected with the coal-mining industry has been the comparatively rapid growth of bituminous, or soft, coal production compared with that of anthracite. This has been especially noticeable during the last quarter of a century, during which statistics have been compiled by the division of mineral resources of the United States Geological Survey.

In the table on page 20 the statistics for the year 1880 are for the fiscal year, as compiled by the Tenth United States Census. The statistics for the Eleventh Census, which cover the calendar year 1889, and for the Twelfth Census, which cover the calendar year 1902, were collected by this division of the Geological Survey in cooperation with the Census Bureau. This table shows that while the production of anthracite has increased from 28,649,812 short tons in 1880, to 85,604,312 short tons in 1907, a gain of 56,954,500 tons, or 199 per cent, the bituminous production has grown from 42,831,758 to 394,759,112 short tons in 1907, an increase of 351,927,354 short tons, or 822 per cent. It was thought in 1905, when the anthracite production reached a total of 69,339,152 long tons, or 77,659,850 short tons, that the maximum had about been reached, but the reports for 1907 show that this record was largely exceeded. If, however, we consider the decreased production in 1906, we find that the average anthracite output for the last two years was 70,038,716 long tons, or 78,443,362 short tons, which compares closely with the average tonnage for the three preceding years. It is well to call attention to the fact that of the total production of anthracite in 1907, 4,301,082 long tons, or 4,817,212 short tons, represent the product of the washeries, most of it recovered from the old culm banks, and is not actually a part of the mines product for 1907 although included in the total tonnage.

Notwithstanding the record made in 1907, it does not appear that anthracite mining will continue to materially increase. The conditions under which the mines are operated, and the increasing cost of labor, with the decreasing tendency in the average productive capacity of the mine workers, are increasing the cost and consequently the selling price of anthracite and making its use slowly but surely more and more a luxury. Little hope can be held out to consumers that there will be any permanent decline in the selling price of anthracite. The close control in which the industry is now held precludes any possibility of cut-throat competition, and the selling of anthracite at less than it costs to produce it, which has been done in previous years. The increased expense in the mining of anthracite and its advancing tendency in price have naturally encouraged the use of other fuels as substitutes for it, and this tendency is constantly growing.

The use of anthracite coal was at one time an important factor in blast-furnace practice and in other manufacturing industries, but such use has now almost entirely ceased. The principal demand for anthracite at the present time, as will be the case in the future, is for domestic purposes, for which such sizes as furnace, egg, stove, and chestnut are required. The breaking down of the lump coal in the preparation of these domestic sizes results in a much greater proportion of the small or undesirable sizes, which are sold at less than the cost of production. As shown in the discussion of anthracite production in the subsequent pages of this report, the percentage of the small sizes has increased from 23.1 in 1890 to 41.4 per cent in 1907, while the percentage of the sizes above pea coal, or what may be termed the profitable sizes, has decreased from 77 to 58.6 per cent. In other words, the proportion of the profitable sizes has decreased 18 per cent, while the proportion of the unprofitable sizes has increased 18.3 per cent. The profits must be obtained from the prepared domestic sizes, and in the face of these conditions no encouragement can be offered to consumers of these grades of anthracite that their fuel bills will be decreased.

During recent years the anthracite operators have adopted the policy of making an allowance of 50 cents per ton from circular prices for domestic coal purchased in April of each year, with an advance of 10 cents per ton for each succeeding month until the schedule prices are restored in September. This has had a more salutary effect in steadying the anthracite trade than any other action taken by those controlling the anthracite industry. Its purpose is to encourage the purchase of coal in the spring and early summer, making the cellars of the consumers the storage places for the following winter, and at the same time causing the mines to be operated more regularly and thus to give more steady employment to employees throughout the year.

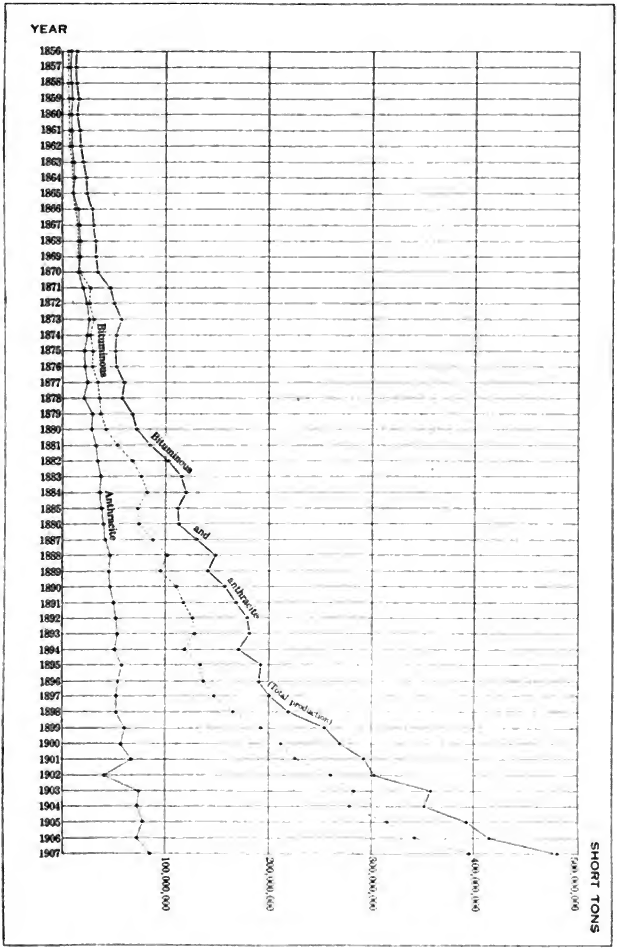


Fig. 2.—Yearly production of anthracite and bituminous coal from 1856 to 1907, in short tons.

*Annual production of coal in the United States, 1880–1907.*

| Year. | Pennsylvania anthracite. | | | Bituminous coal. | | |
|---|---|---|---|---|---|---|
| | Quantity. | | Value. | Quantity. | | Value. |
| | *Long tons.* | *Short tons.* | | *Long tons.* | *Short tons.* | |
| 1880 | 25,580,189 | 28,649,812 | $42,196,678 | 38,242,641 | 42,831,758 | $58,443,718 |
| 1881 | 28,500,016 | 31,920,018 | 64,125,036 | 48,179,475 | 53,961,012 | 60,224,344 |
| 1882 | 31,358,264 | 35,121,256 | 70,556,094 | 61,098,154 | 68,429,933 | 76,076,487 |
| 1883 | 34,336,469 | 38,456,845 | 77,257,055 | 68,973,821 | 77,250,680 | 82,237,800 |
| 1884 | 33,175,756 | 37,156,847 | 66,351,512 | 74,105,986 | 82,998,704 | 77,417,066 |
| 1885 | 34,228,548 | 38,335,974 | 76,671,948 | 65,021,715 | 72,824,321 | 82,347,648 |
| 1886 | 34,853,077 | 39,035,446 | 76,119,120 | 66,647,304 | 74,644,981 | 78,481,056 |
| 1887 | 37,578,747 | 42,088,197 | 84,552,181 | 79,073,495 | 88,562,314 | 98,004,656 |
| 1888 | 41,624,611 | 46,619,564 | 89,020,483 | 91,107,226 | 102,040,093 | 101,860,529 |
| 1889 | 40,666,938 | 45,546,970 | 65,721,578 | 85,430,842 | 95,682,543 | 94,504,745 |
| 1890 | 41,489,858 | 46,468,641 | 66,383,772 | 99,377,073 | 111,302,322 | 110,420,801 |
| 1891 | 45,236,992 | 50,665,431 | 73,944,735 | 105,268,962 | 117,901,238 | 117,188,400 |
| 1892 | 46,850,450 | 52,472,504 | 82,442,000 | 113,264,792 | 126,856,567 | 125,124,381 |
| 1893 | 48,185,306 | 53,967,543 | 85,687,078 | 114,629,671 | 128,385,231 | 122,751,618 |
| 1894 | 46,358,144 | 51,921,121 | 78,488,063 | 106,089,647 | 118,820,405 | 107,653,501 |
| 1895 | 51,785,122 | 57,999,337 | 82,019,272 | 120,641,244 | 135,118,193 | 115,779,771 |
| 1896 | 48,523,287 | 54,346,081 | 81,748,651 | 122,893,104 | 137,640,276 | 114,891,515 |
| 1897 | 46,974,714 | 52,611,680 | 79,301,954 | 131,801,356 | 147,617,519 | 119,595,224 |
| 1898 | 47,663,076 | 53,382,644 | 75,414,537 | 148,744,306 | 166,593,623 | 132,608,713 |
| 1899 | 53,944,647 | 60,418,005 | 88,142,130 | 172,609,988 | 193,323,187 | 167,952,104 |
| 1900 | 51,221,353 | 57,367,915 | 85,757,851 | 189,567,957 | 212,316,112 | 220,930,313 |
| 1901 | 60,242,560 | 67,471,667 | 112,504,020 | 201,632,276 | 225,828,149 | 236,422,049 |
| 1902 | 36,940,710 | 41,373,595 | 76,173,586 | 232,336,468 | 260,216,844 | 290,858,483 |
| 1903 | 66,613,454 | 74,607,068 | 152,036,448 | 252,454,775 | 282,749,348 | 351,687,933 |
| 1904 | 65,318,490 | 73,156,709 | 138,974,020 | 248,803,293 | 278,659,689 | 305,397,001 |
| 1905 | 69,339,152 | 77,659,850 | 141,879,000 | 281,306,058 | 315,062,785 | 334,658,294 |
| 1906 | 63,645,010 | 71,282,411 | 131,917,694 | 306,138,274 | 342,874,867 | 381,162,115 |
| 1907 | 76,432,421 | 85,604,312 | 163,584,056 | 352,463,493 | 394,759,112 | 451,214,842 |

| Year. | Total. | | |
|---|---|---|---|
| | Quantity. | | Value. |
| | *Long tons.* | *Short tons.* | |
| 1880 | 63,822,830 | 71,481,570 | $100,640,396 |
| 1881 | 76,679,491 | 85,881,030 | 124,349,380 |
| 1882 | 92,456,419 | 103,551,189 | 146,632,581 |
| 1883 | 103,310,290 | 115,707,525 | 159,494,855 |
| 1884 | 107,281,742 | 120,155,551 | 143,768,578 |
| 1885 | 99,250,263 | 111,160,295 | 159,019,596 |
| 1886 | 101,500,381 | 113,680,427 | 154,600,176 |
| 1887 | 116,652,242 | 130,650,511 | 182,556,837 |
| 1888 | 132,731,837 | 148,659,657 | 190,881,012 |
| 1889 | 126,097,779 | 141,229,513 | 160,226,323 |
| 1890 | 140,866,931 | 157,770,963 | 176,804,573 |
| 1891 | 150,505,954 | 168,566,669 | 191,133,135 |
| 1892 | 160,115,242 | 179,329,071 | 207,566,381 |
| 1893 | 162,814,977 | 182,352,774 | 208,438,696 |
| 1894 | 152,447,791 | 170,741,526 | 186,141,564 |
| 1895 | 172,426,366 | 193,117,530 | 197,799,043 |
| 1896 | 171,416,390 | 191,986,357 | 196,640,166 |
| 1897 | 178,776,070 | 200,229,199 | 198,897,178 |
| 1898 | 196,407,382 | 219,976,267 | 208,023,250 |
| 1899 | 226,554,635 | 253,741,192 | 256,094,234 |
| 1900 | 240,789,310 | 269,684,027 | 306,688,164 |
| 1901 | 261,874,836 | 293,299,816 | 348,926,069 |
| 1902 | 269,277,178 | 301,590,439 | 367,032,069 |
| 1903 | 319,068,229 | 357,356,416 | 503,724,381 |
| 1904 | 314,121,783 | 351,816,398 | 444,371,021 |
| 1905 | 350,645,210 | 392,722,635 | 476,537,294 |
| 1906 | 369,783,284 | 414,157,278 | 513,079,809 |
| 1907 | 428,895,914 | 480,363,424 | 614,798,898 |

The statistics regarding the distribution of the coal production of the United States for consumption have been obtained only since 1889. These are shown in the following table, together with the value of the product, the statistics of labor employed, and the average working time made by mine employees:

*Distribution of the coal product of the United States, 1889–1907, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. |
|---|---|---|---|---|
| 1889 | 113,776,701 | 8,508,699 | 5,382,265 | 13,561,848 |
| 1890 | 128,365,965 | 9,009,285 | 5,063,953 | 15,331,760 |
| 1891 | 137,920,346 | 8,871,882 | 6,056,001 | 15,718,440 |
| 1892 | 146,372,098 | 9,704,678 | 6,210,767 | 17,041,528 |
| 1893 | 152,941,890 | 9,728,815 | 6,712,284 | 12,969,785 |
| 1894 | 142,833,319 | 8,764,538 | 6,307,296 | 12,836,373 |
| 1895 | 158,380,289 | 9,655,505 | 6,677,539 | 18,404,197 |
| 1896 | 159,176,155 | 9,502,927 | 7,184,832 | 16,122,443 |
| 1897 | 165,603,626 | 9,922,276 | 6,941,419 | 17,761,878 |
| 1898 | 180,960,111 | 8,927,514 | 7,921,289 | 22,167,353 |
| 1899 | 208,754,746 | 9,075,756 | 8,662,864 | 27,247,826 |
| 1900 | 223,782,088 | 9,077,242 | 9,189,746 | 27,634,951 |
| 1901 | 245,010,812 | 9,595,308 | 10,379,546 | 28,314,150 |
| 1902 | 247,642,852 | 9,781,996 | 9,995,861 | 34,169,730 |
| 1903 | 299,813,428 | 11,107,917 | 12,633,653 | 33,801,418 |
| 1904 | 296,142,355 | 16,519,043 | 7,876,463 | 31,278,537 |
| 1905 | 324,059,447 | 12,208,687 | 14,042,173 | 42,412,328 |
| 1906 | 341,526,755 | 11,640,238 | 14,833,984 | 46,156,301 |
| 1907 | 399,421,195 | 13,091,034 | 17,561,373 | 50,289,822 |

| Year. | Total product | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|
| 1889 | 141,229,513 | $160,226,323 | $1.13 | ........ | ........ |
| 1890 | 157,770,963 | 176,804,573 | 1.12 | 216 | 318,204 |
| 1891 | 168,566,669 | 191,133,135 | 1.13 | 223 | 205,803 |
| 1892 | 179,329,071 | 207,566,381 | 1.16 | 212 | 341,943 |
| 1893 | 182,352,774 | 208,438,696 | 1.14 | 201 | 363,309 |
| 1894 | 170,741,526 | 186,141,564 | 1.09 | 178 | 376,206 |
| 1895 | 193,117,530 | 197,799,043 | 1.02 | 195 | 382,879 |
| 1896 | 191,986,357 | 196,640,166 | 1.02 | 185 | 386,656 |
| 1897 | 200,229,199 | 198,897,178 | .99 | 179 | 397,701 |
| 1898 | 219,976,267 | 208,023,250 | .95 | 190 | 401,221 |
| 1899 | 253,741,192 | 256,094,234 | 1.01 | 214 | 410,635 |
| 1900 | 269,684,027 | 306,688,164 | 1.14 | 212 | 448,581 |
| 1901 | 293,299,816 | 348,926,069 | 1.19 | 216 | 485,544 |
| 1902 | 301,590,439 | 367,032,069 | 1.22 | 197 | 518,197 |
| 1903 | 357,356,416 | 503,724,381 | 1.41 | 220 | 566,250 |
| 1904 | 351,816,398 | 444,371,021 | 1.26 | 202 | 593,693 |
| 1905 | 392,722,635 | 476,537,204 | 1.21 | 212 | 626,035 |
| 1906 | 414,157,278 | 513,079,809 | 1.24 | 209 | 640,780 |
| 1907 | 480,363,424 | 614,798,898 | 1.28 | 231 | 680,492 |

In the following table is presented a statement showing how the coal production of the five principal States—Pennsylvania, Illinois, West Virginia, Ohio, and Alabama—has grown relatively to the total production since 1860. The statistics are given for each 10 years, from 1860 to 1900, and annually, from 1901 to 1907, inclusive. It will be observed that Pennsylvania's proportion has decreased from 74 per cent in 1860 to 49.1 per cent in 1907. West Virginia, which was not a State in 1860, contributed 1.8 per cent in 1870 and 10 per cent in 1907. Illinois produced 5 per cent in 1860 and 10.7 per cent in 1907. Ohio's percentage has declined from 8.7 to 6.7 per cent, while Alabama's has grown from 0.07 to 3.2 per cent.

*Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1907, in short tons.*

| Year. | Total production, United States. | Pennsylvania. | | West Virginia. | |
|---|---|---|---|---|---|
| | | Production. | Percentage of total production. | Production. | Percentage of total production. |
| 1860 | 14,610,042 | 10,806,628 | 74.0 | .......... | .......... |
| 1870 | 33,035,580 | 23,462,793 | 71.0 | 608,878 | 1.8 |
| 1880 | 71,481,570 | 47,074,975 | 65.9 | 1,829,844 | 2.6 |
| 1890 | 157,770,963 | 88,770,814 | 56.3 | 7,394,654 | 4.7 |
| 1900 | 269,684,027 | 137,210,241 | 50.9 | 22,647,207 | 8.4 |
| 1901 | 293,299,816 | 149,777,613 | 51.1 | 24,068,402 | 8.2 |
| 1902 | 301,590,439 | 139,947,962 | 46.4 | 24,570,826 | 8.1 |
| 1903 | 357,356,416 | 177,724,246 | 49.7 | 29,337,241 | 8.2 |
| 1904 | 351,816,398 | 171,094,996 | 48.6 | 32,406,752 | 9.2 |
| 1905 | 392,722,635 | 196,073,487 | 49.9 | 37,791,580 | 9.6 |
| 1906 | 414,157,278 | 200,575,617 | 48.4 | 43,290,350 | 10.5 |
| 1907 | 480,363,424 | 235,747,489 | 49.1 | 48,091,583 | 10.0 |

| Year. | Illinois. | | Ohio. | | Alabama. | |
|---|---|---|---|---|---|---|
| | Production. | Percentage of total production. | Production. | Percentage of total production. | Production. | Percentage of total production. |
| 1860 | 728,400 | 5.0 | 1,265,600 | 8.7 | 10,200 | 0.07 |
| 1870 | 2,624,163 | 7.9 | 2,527,285 | 7.7 | 11,000 | .03 |
| 1880 | 6,115,377 | 8.6 | 6,008,595 | 8.4 | 323,972 | .45 |
| 1890 | 15,292,420 | 9.7 | 11,494,506 | 7.3 | 4,090,409 | 2.6 |
| 1900 | 25,767,981 | 9.6 | 18,988,150 | 7.0 | 8,394,275 | 3.1 |
| 1901 | 27,331,552 | 9.3 | 20,943,807 | 7.1 | 9,099,052 | 3.1 |
| 1902 | 32,939,373 | 10.9 | 23,519,894 | 7.8 | 10,354,570 | 3.4 |
| 1903 | 36,957,104 | 10.3 | 24,838,103 | 7.0 | 11,654,324 | 3.3 |
| 1904 | 36,475,060 | 10.4 | 24,400,220 | 6.9 | 11,262,046 | 3.2 |
| 1905 | 38,434,363 | 9.8 | 25,552,950 | 6.5 | 11,866,069 | 3.0 |
| 1906 | 41,480,104 | 10.0 | 27,731,640 | 6.7 | 13,107,963 | 3.2 |
| 1907 | 51,317,146 | 10.7 | 32,142,419 | 6.7 | 14,250,454 | 3.0 |

## PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1907.

So far as known, the first mention of the occurrence of coal in the United States is contained in the journal of Father Hennepin, a Jesuit missionary, who in 1679 recorded a "cole mine" on Illinois River, near the present city of Ottawa, Ill. The first actual mining of coal was in the Richmond basin, Virginia, about 70 years after Father Hennepin's discovery in Illinois, but the first records of production from the Virginia mines were for the year 1822, when, according to one authority, 54,000 tons were mined. Ohio probably ranks second in priority of production, as coal was discovered there in 1755, but the records of production date back only to 1838. The mining of anthracite in Pennsylvania began about 1790, and it is said that in 1807 55 tons were shipped to Columbia, Pa. Reports of the anthracite coal trade are usually begun with the year 1820, when 365 tons, 1 ton for each day of the year, were shipped to Philadelphia from the Lehigh region. Prior to this, however, in 1814, a shipment of 22 tons was made from Carbondale, also to Philadelphia, and in the following table the production is considered to have begun in that year. It is probable that the actual production prior to 1820 was between 2,500 and 3,000 tons.

From 1814 to the close of 1907 the total quantity of coal produced in the United States has amounted to 6,865,097,567 short tons. More than 55 per cent of this, or 3,777,579,574 short tons, has been mined in Pennsylvania, the anthracite production in that State having amounted to 1,931,510,321 short tons, while the bituminous output of Pennsylvania has amounted to 1,846,069,253 short tons.

Illinois ranks second, with a total production of 645,868,309 tons, and Ohio third, with 492,769,358 tons; West Virginia, although not coming into existence as a separate State until 1863, ranks fourth, with a total production in 45 years of 434,198,539 tons; Alabama comes fifth, with 164,734,310 tons; and Indiana sixth, with 159,440,390 tons.

The following table gives the production in each State from the date of earliest record to the close of 1907:

*Production of coal in the United States from 1814 to the close of 1907, in short tons.*

| Year. | Pennsylvania. | Virginia. | Kentucky. | Illinois. | Ohio. | Pennsylvania. | Missouri. | Indiana. | Alabama. | Tennessee. | Iowa. | Arkansas. | North Carolina. | Maryland. | Washington. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Anthracite.* | | | | | *Bituminous.* | | | | | | | | | |
| 1814 | 22 | | | | | | | | | | | | | | |
| 1815 | 50 | | | | | | | | | | | | | | |
| 1816 | 75 | | | | | | | | | | | | | | |
| 1817 | 100 | | | | | | | | | | | | | | |
| 1818 | 200 | | | | | | | | | | | | | | |
| 1819 | 350 | | | | | | | | | | | | | | |
| 1820 | 450 | | | | | | | | | | | | | 3,000 | |
| 1821 | 1,322 | | | | | | | | | | | | | | |
| 1822 | 4,583 | 54,000 | | | | | | | | | | | | | |
| 1823 | 8,563 | 60,000 | | | | | | | | | | | | | |
| 1824 | 13,685 | 67,040 | | | | | | | | | | | | | |
| 1825 | 42,988 | 75,000 | | | | | | | | | | | | | |
| 1826 | 59,194 | 88,720 | | | | | | | | | | | | | |
| 1827 | 78,151 | 94,000 | | | | | | | | | | | | | |
| 1828 | 95,500 | 100,080 | 328 | | | | | | | | | | | | |
| 1829 | 138,086 | 100,000 | 2,000 | | | | | | | | | | | | |
| 1830 | 215,272 | 102,800 | 2,000 | | | | | | | | | | | | |
| 1831 | 217,842 | 118,000 | 2,100 | | | | | | | | | | | | |
| 1832 | 447,550 | 132,000 | 2,500 | | | | | | | | | | | 12,000 | |
| 1833 | 600,907 | 125,000 | 2,750 | 6,000 | | | | | | | | | | | |
| 1834 | 464,015 | 124,000 | 5,000 | 7,500 | | | | | | | | | | | |
| 1835 | 690,854 | 120,000 | 6,000 | 8,000 | | | | | | | | | | | |
| 1836 | 842,832 | 124,000 | 8,000 | 10,000 | | | | | | | | | | | |
| 1837 | 1,071,151 | 160,000 | 10,000 | 12,500 | | | | | | | | | | | |
| 1838 | 910,075 | 300,000 | 11,500 | 14,000 | 119,952 | | | | | | | | | | |
| 1839 | 1,008,322 | 396,000 | 16,000 | 15,038 | 125,000 | | | | | | | | | | |
| 1840 | 967,108 | 424,894 | 23,527 | 16,967 | 140,536 | 464,826 | 9,972 | 9,682 | 946 | 558 | 400 | 220 | 3 | 8,880 | |
| 1841 | 1,182,441 | 379,600 | 35,000 | 35,000 | 160,000 | 475,000 | 12,000 | 10,000 | 1,000 | 600 | 500 | | | | |
| 1842 | 1,365,563 | 373,640 | 50,000 | 58,000 | 225,000 | 500,000 | 15,000 | 18,000 | 1,000 | 1,000 | 750 | | | 2,104 | |
| 1843 | 1,559,753 | 370,000 | 60,000 | 75,000 | 280,000 | 650,000 | 25,000 | 25,000 | 1,200 | 4,500 | 1,000 | | | 12,421 | |
| 1844 | 2,009,207 | 365,000 | 75,000 | 120,000 | 340,000 | 675,000 | 35,000 | 30,000 | 1,200 | 10,000 | 2,500 | | | 18,345 | |
| 1845 | 2,480,032 | 350,000 | 100,000 | 150,000 | 390,000 | 700,000 | 50,000 | 35,000 | 1,500 | 18,000 | 5,000 | | | 30,372 | |
| 1846 | 2,887,815 | 340,000 | 115,000 | 165,000 | 420,000 | 760,000 | 68,000 | 40,000 | 1,500 | 25,000 | 6,500 | | | 36,707 | |
| 1847 | 3,551,005 | 325,000 | 120,000 | 180,000 | 480,000 | 399,840 | 80,000 | 45,000 | 2,000 | 30,000 | 8,000 | | | 65,222 | |
| 1848 | 3,805,942 | 318,000 | 125,000 | 200,000 | 540,000 | 500,000 | 85,000 | 50,000 | 2,000 | 40,000 | 10,000 | | | 98,032 | |
| 1849 | 3,995,334 | 315,000 | 140,000 | 260,000 | 600,000 | 750,000 | 90,000 | 56,000 | 2,500 | 52,000 | 12,500 | | | 175,497 | |
| 1850 | 4,138,164 | 310,000 | 150,000 | 300,000 | 640,000 | 1,000,000 | 100,000 | 60,000 | 2,500 | 60,000 | 15,000 | | | 242,517 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1851..... | 5,481,065 | 310,000 | 160,000 | 320,000 | 670,000 | 1,200,000 | 125,000 | 60,000 | 3,000 | 70,000 | 18,000 | .......... | .......... | 317,460 | .......... |
| 1852..... | 6,151,957 | 325,000 | 175,000 | 340,000 | 700,000 | 1,400,000 | 140,000 | 75,000 | 3,000 | 75,000 | 20,000 | .......... | .......... | 411,707 | .......... |
| 1853..... | 6,400,426 | 350,000 | 180,000 | 375,000 | 760,000 | 1,500,000 | 160,000 | 75,000 | 4,000 | 85,000 | 23,000 | .......... | .......... | 657,862 | .......... |
| 1854..... | 7,394,875 | 370,000 | 190,000 | 385,000 | 800,000 | 1,650,000 | 175,000 | 80,000 | 4,500 | 90,000 | 25,000 | .......... | .......... | 812,727 | .......... |
| 1855..... | 8,141,754 | 380,782 | 200,000 | 400,000 | 890,000 | 1,780,000 | 185,000 | 80,000 | 6,000 | 100,000 | 28,000 | .......... | .......... | 735,137 | .......... |
| 1856..... | 8,534,779 | 352,687 | 215,000 | 410,000 | 930,000 | 1,850,000 | 200,000 | 85,000 | 6,800 | 115,000 | 30,000 | .......... | .......... | 817,659 | .......... |
| 1857..... | 8,186,567 | 363,605 | 240,000 | 450,000 | 975,000 | 2,000,000 | 220,000 | 85,000 | 8,000 | 125,000 | 33,000 | .......... | .......... | 654,017 | .......... |
| 1858..... | 8,426,102 | 377,690 | 250,000 | 490,000 | 1,000,000 | 2,200,000 | 240,000 | 87,000 | 8,500 | 135,000 | 37,500 | .......... | .......... | 722,686 | .......... |
| 1859..... | 9,619,771 | 359,055 | 275,000 | 530,000 | 1,060,000 | 2,400,000 | 260,000 | 95,000 | 9,000 | 150,000 | 42,000 | .......... | .......... | 833,349 | .......... |
| 1860..... | 8,115,842 | 473,360 | 285,760 | 728,400 | 1,265,600 | 2,690,786 | 280,000 | 101,280 | 10,200 | 165,300 | 41,920 | 200 | .......... | 438,000 | 5,374 |
| 1861..... | 9,799,654 | 445,165 | 280,000 | 670,000 | 1,150,000 | 3,200,000 | 300,000 | 128,000 | 10,000 | 150,000 | 50,000 | .......... | .......... | 287,073 | 6,000 |
| 1862..... | 9,695,110 | 445,124 | 275,000 | 780,000 | 1,200,000 | 4,000,000 | 320,000 | 150,000 | 12,500 | 140,000 | 53,000 | .......... | 30,000 | 346,201 | 7,000 |
| 1863..... | 11,785,320 | 40,000 | 250,000 | 890,000 | 1,204,581 | 5,000,000 | 360,000 | 200,000 | 15,000 | 100,000 | 57,000 | .......... | 30,000 | 877,313 | 8,000 |
| 1864..... | 12,538,649 | 40,000 | 250,000 | 1,000,000 | 1,815,622 | 5,839,000 | 375,000 | 250,000 | 15,000 | 100,000 | 63,000 | .......... | 25,000 | 755,764 | 10,000 |
| 1865..... | 11,891,746 | 40,000 | 200,000 | 1,260,000 | 1,536,218 | 6,350,000 | 420,000 | 280,000 | 12,000 | 100,000 | 69,574 | .......... | 20,000 | 1,025,208 | 12,000 |
| 1866..... | 15,651,183 | 40,000 | 180,000 | 1,580,000 | 1,887,424 | 6,800,000 | 450,000 | 320,000 | 12,000 | 100,000 | 99,320 | .......... | 20,000 | 1,217,668 | 13,000 |
| 1867..... | 16,002,109 | 50,000 | 175,000 | 1,800,000 | 2,092,334 | 7,300,000 | 500,000 | 350,000 | 10,000 | 110,000 | 150,000 | .......... | 20,000 | 1,381,429 | 14,500 |
| 1868..... | 17,003,405 | 59,051 | 160,000 | 2,000,000 | 2,475,844 | 7,500,000 | 541,000 | 375,000 | 10,000 | 125,000 | 241,453 | .......... | 18,000 | 1,529,879 | 15,000 |
| 1869..... | 17,083,134 | 65,000 | 160,000 | 1,854,000 | 2,461,986 | 6,750,000 | 550,000 | 400,000 | 10,000 | 130,000 | 295,105 | .......... | 16,000 | 2,216,300 | 16,200 |
| 1870..... | 15,664,275 | 61,803 | 150,582 | 2,624,163 | 2,527,285 | 7,798,518 | 621,930 | 437,870 | 11,000 | 133,418 | 263,487 | .......... | 15,000 | 1,819,824 | 17,844 |
| 1871..... | 19,342,057 | 70,000 | 250,000 | 3,000,000 | 4,000,000 | 9,040,565 | 725,000 | 600,000 | 15,000 | 180,000 | 300,000 | .......... | 15,000 | 2,670,338 | 20,000 |
| 1872..... | 24,233,166 | 69,440 | 380,800 | 3,360,000 | 5,315,294 | 11,695,040 | 784,000 | 896,000 | 16,800 | 224,000 | 336,000 | .......... | 12,000 | 2,647,156 | 23,000 |
| 1873..... | 26,152,837 | 67,200 | 400,000 | 3,920,000 | 4,550,028 | 13,098,829 | 784,000 | 1,000,000 | 44,800 | 350,000 | 392,000 | .......... | 10,000 | 3,198,911 | 26,000 |
| 1874..... | 24,818,790 | 70,000 | 360,000 | 4,203,000 | 3,267,585 | 12,320,000 | 789,680 | 812,000 | 50,400 | 350,000 | 799,936 | .......... | .......... | 2,899,392 | 30,352 |
| 1875..... | 22,485,766 | 60,000 | 500,000 | 4,452,178 | 4,864,259 | 11,760,000 | 840,000 | 800,000 | 67,200 | 360,000 | 1,231,547 | .......... | .......... | 2,808,018 | 99,568 |
| 1876..... | 22,793,245 | 55,000 | 650,000 | 5,000,000 | 3,500,000 | 12,880,000 | 1,008,000 | 950,000 | 112,000 | 550,000 | 1,250,000 | .......... | .......... | 2,126,873 | 110,342 |
| 1877..... | 25,660,316 | 50,000 | 850,000 | 5,350,000 | 5,250,000 | 14,000,000 | 1,008,000 | 1,000,000 | 196,000 | 450,000 | 1,300,000 | .......... | .......... | 1,939,575 | 120,896 |
| 1878..... | 21,689,682 | 50,000 | 900,000 | 5,700,000 | 5,500,000 | 15,120,000 | 1,008,000 | 1,000,000 | 224,000 | 375,000 | 1,350,000 | .......... | .......... | 2,068,925 | 131,660 |
| 1879..... | 30,207,793 | 45,000 | 1,000,000 | 5,000,000 | 6,000,000 | 16,240,000 | 1,008,000 | 1,196,490 | 280,000 | 450,000 | 1,400,000 | .......... | .......... | 2,132,233 | 142,666 |
| 1880..... | 28,649,812 | 43,079 | 946,288 | 6,115,377 | 6,008,595 | 18,425,163 | 844,304 | 1,454,327 | 323,972 | 495,131 | 1,461,116 | 14,778 | 330 | 2,228,917 | 145,015 |
| 1881..... | 31,920,018 | 50,000 | 1,232,000 | 6,720,000 | 9,240,000 | 22,400,000 | 1,960,000 | 1,984,120 | 420,000 | 840,000 | 1,960,000 | 20,000 | 300 | 2,533,348 | 196,000 |
| 1882..... | 35,121,256 | 112,000 | 1,300,000 | 9,115,653 | 9,450,000 | 24,640,000 | 2,240,000 | 1,976,470 | 896,000 | 850,000 | 3,920,000 | 25,000 | 400 | 1,555,445 | 177,340 |
| 1883..... | 38,456,845 | 252,000 | 1,650,000 | 12,123,456 | 8,229,429 | 26,880,000 | 2,520,000 | 2,560,000 | 1,568,000 | 1,000,000 | 4,457,540 | 50,000 | 400 | 2,476,075 | 244,990 |
| 1884..... | 37,156,847 | 336,000 | 1,550,000 | 12,208,075 | 7,640,062 | 28,000,000 | 2,800,000 | 2,260,000 | 2,240,000 | 1,200,000 | 4,370,566 | 75,000 | 500 | 2,765,617 | 166,936 |
| 1885..... | 38,335,974 | 567,000 | 1,600,000 | 11,834,459 | 7,816,179 | 26,000,000 | 3,080,000 | 2,375,000 | 2,492,000 | 1,440,957 | 4,012,575 | 100,000 | 500 | 2,833,337 | 380,250 |
| 1886..... | 39,035,446 | 684,951 | 1,550,000 | 11,175,241 | 8,435,211 | 27,094,501 | 1,800,000 | 3,000,000 | 1,800,000 | 1,714,290 | 4,315,779 | 125,000 | 400 | 2,517,577 | 423,525 |
| 1887..... | 42,088,197 | 825,263 | 1,933,185 | 12,423,066 | 10,300,708 | 31,516,856 | 3,209,916 | 3,217,711 | 1,950,000 | 1,900,000 | 4,473,828 | 129,600 | 300 | 3,278,023 | 772,601 |
| 1888..... | 46,619,564 | 1,073,000 | 2,570,000 | 14,328,181 | 10,910,951 | 33,796,727 | 3,909,967 | 3,140,979 | 2,900,000 | 1,967,297 | 4,952,440 | 276,871 | 250 | 3,479,470 | 1,215,750 |
| 1889..... | 45,546,970 | 865,786 | 2,399,755 | 12,104,272 | 9,976,787 | 36,174,089 | 2,557,823 | 2,845,057 | 3,572,983 | 1,925,689 | 4,095,358 | 279,584 | 222 | 2,939,715 | 1,030,578 |
| 1890..... | 46,468,641 | 784,011 | 2,701,496 | 15,292,420 | 11,494,506 | 42,302,173 | 2,735,221 | 3,305,737 | 4,090,409 | 2,169,585 | 4,021,739 | 399,888 | 10,262 | 3,357,813 | 1,263,689 |

*Production of coal in the United States from 1814 to the close of 1907, in short tons*—Continued.

| Year. | Pennsylvania. | Virginia. | Kentucky. | Illinois. | Ohio. | Pennsylvania. | Missouri. | Indiana. | Alabama. | Tennessee. | Iowa. | Arkansas. | North Carolina. | Maryland. | Washington. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | *Anthracite.* |  |  |  |  | *Bituminous.* |  |  |  |  |  |  |  |  |  |
| 1891..... | 50,665,431 | 736,399 | 2,916,069 | 15,660,698 | 12,868,683 | 42,788,490 | 2,674,606 | 2,973,474 | 4,759,781 | 2,413,678 | 3,825,495 | 542,379 | 20,355 | 3,820,239 | 1,056,249 |
| 1892..... | 52,472,504 | 675,205 | 3,025,313 | 17,862,276 | 13,562,927 | 46,694,576 | 2,733,949 | 3,345,174 | 5,529,312 | 2,092,064 | 3,918,491 | 535,558 | 6,679 | 3,419,962 | 1,213,427 |
| 1893..... | 53,967,543 | 820,339 | 3,007,179 | 19,949,564 | 13,253,646 | 44,070,724 | 2,897,442 | 3,791,851 | 5,136,935 | 1,902,258 | 3,972,229 | 574,763 | 17,000 | 3,716,041 | 1,264,877 |
| 1894..... | 51,921,121 | 1,229,083 | 3,111,192 | 17,113,576 | 11,909,856 | 39,912,463 | 2,245,039 | 3,423,921 | 4,397,178 | 2,180,879 | 3,967,253 | 512,626 | 16,900 | 3,501,428 | 1,106,470 |
| 1895..... | 57,999,337 | 1,368,324 | 3,357,770 | 17,735,864 | 13,355,806 | 50,217,228 | 2,372,393 | 3,995,892 | 5,693,775 | 2,535,644 | 4,156,074 | 598,322 | 24,900 | 3,915,585 | 1,191,410 |
| 1896..... | 54,346,081 | 1,254,723 | 3,333,478 | 19,786,626 | 12,875,202 | 49,557,453 | 2,331,542 | 3,905,779 | 5,748,697 | 2,663,106 | 3,954,028 | 675,374 | 7,813 | 4,143,936 | 1,195,504 |
| 1897..... | 52,611,680 | 1,528,302 | 3,602,097 | 20,072,758 | 12,196,942 | 54,417,974 | 2,665,626 | 4,151.169 | 5,893,770 | 2,888,849 | 4,611,865 | 856,190 | 21,280 | 4,442,128 | 1,434,112 |
| 1898..... | 53,382,644 | 1,815,274 | 3,887,908 | 18,599,299 | 14,516,867 | 65,165,133 | 2,688,321 | 4,920,743 | 6,535,283 | 3,022,896 | 4,618,842 | 1,205,479 | 11,495 | 4,674,884 | 1,884,571 |
| 1899..... | 60,418,005 | 2,105,791 | 4,607,255 | 24,439,019 | 16,500,270 | 74,150,175 | 3,025,814 | 6,006,523 | 7,593,416 | 3,330,659 | 5,177,479 | 843,554 | 26,896 | 4,807,396 | 2,029,881 |
| 1900..... | 57,367,915 | 2,393,754 | 5,328,964 | 25,767,981 | 18,988,150 | 79,842,326 | 3,540,103 | 6,484,086 | 8,394,275 | 3,509,562 | 5,202,939 | 1,447,945 | 17,734 | 4,024,688 | 2,474,093 |
| 1901..... | 67,471,667 | 2,725,873 | 5,469,986 | 27,331,552 | 20,943,807 | 82,305,946 | 3,802,088 | 6,918,225 | 9,099,052 | 3,633,290 | 5,617,499 | 1,816,136 | 12,000 | 5,113,127 | 2,578,217 |
| 1902..... | 41,373,595 | 3,182,993 | 6,766,984 | 32,939,373 | 23,519,894 | 98,574,367 | 3,890,154 | 9,446,424 | 10,354,570 | 4,382,968 | 5,904,766 | 1,943,932 | 23,000 | 5,271,609 | 2,681,214 |
| 1903..... | 74,607,068 | 3,451,307 | 7,538,032 | 36,957,104 | 24,838,103 | 103,117,178 | 4,238,586 | 10,794,692 | 11,654,324 | 4,798,004 | 6,419,811 | 2,229,172 | 17,309 | 4,846,165 | 3,193,273 |
| 1904..... | 73,156,709 | 3,410,914 | 7,576,482 | 36,475,060 | 24,400,220 | 97,938,287 | 4,168,308 | 10,842,189 | 11,262,046 | 4,782,211 | 6,519,933 | 2,009,451 | 7,000 | 4,813,622 | 3,137,681 |
| 1905..... | 77,659,850 | 4,275,271 | 8,432,523 | 38,434,363 | 25,552,950 | 118,413,637 | 3,983,378 | 11,895,252 | 11,866,069 | 5,766,690 | 6,798,609 | 1,934,673 | 1,557 | 5,108,539 | 2,864,926 |
| 1906..... | 71,282,411 | 4,254,879 | 9,653,647 | 41,480,104 | 27,731,640 | 129,293,206 | 3,758.008 | 12,092,560 | 13,107,963 | 6,259,275 | 7,266,224 | 1,864,268 | .......... | 5,435,453 | 3,276,184 |
| 1907..... | 85,604,312 | 4,710,895 | 10,753,124 | 51,317,146 | 32,142,419 | 150,143,177 | 3,997,936 | 13,985,713 | 14,250,454 | 6,810,243 | 7,574,322 | 2,670,438 | .......... | 5,532,628 | 3,680,532 |
| Total . | 1,931,510,321 | 57,229,152 | 122,404,574 | 645,868,309 | 492,769,358 | 1,846,069,253 | 97,618,106 | 159,440,390 | 164,734,310 | 84,304,601 | 141,608,792 | 23,756,401 | 476,805 | 147,606,548 | 43,108,697 |

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

*Production of coal in the United States from 1814 to the close of 1907, in short tons*—Continued.

| Year. | Michigan. | Georgia. | California. | West Virginia. | Colorado. | Wyoming. | Kansas. | Utah. | Oklahoma (Ind. T.). | Oregon. | Montana. | New Mexico. | Texas. | North Dakota. | Miscellaneous.[a] | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1814 | | | | | | | | | | | | | | | | 22 |
| 1815 | | | | | | | | | | | | | | | | 50 |
| 1816 | | | | | | | | | | | | | | | | 75 |
| 1817 | | | | | | | | | | | | | | | | 100 |
| 1818 | | | | | | | | | | | | | | | | 200 |
| 1819 | | | | | | | | | | | | | | | | 350 |
| 1820 | | | | | | | | | | | | | | | | 3,450 |
| 1821 | | | | | | | | | | | | | | | | 1,322 |
| 1822 | | | | | | | | | | | | | | | | 58,583 |
| 1823 | | | | | | | | | | | | | | | | 68,563 |
| 1824 | | | | | | | | | | | | | | | | 80,725 |
| 1825 | | | | | | | | | | | | | | | | 117,988 |
| 1826 | | | | | | | | | | | | | | | | 147,914 |
| 1827 | | | | | | | | | | | | | | | | 172,151 |
| 1828 | | | | | | | | | | | | | | | | 195,908 |
| 1829 | | | | | | | | | | | | | | | | 240,086 |
| 1830 | | | | | | | | | | | | | | | | 320,072 |
| 1831 | | | | | | | | | | | | | | | | 337,942 |
| 1832 | | | | | | | | | | | | | | | | 594,050 |
| 1833 | | | | | | | | | | | | | | | | 734,657 |
| 1834 | | | | | | | | | | | | | | | | 600,515 |
| 1835 | | | | | | | | | | | | | | | | 824,854 |
| 1836 | | | | | | | | | | | | | | | | 984,832 |
| 1837 | | | | | | | | | | | | | | | | 1,253,651 |
| 1838 | | | | | | | | | | | | | | | | 1,355,527 |
| 1839 | | | | | | | | | | | | | | | | 1,560,360 |
| 1840 | | | | | | | | | | | | | | | 1,520 | 2,070,039 |
| 1841 | | | | | | | | | | | | | | | | 2,291,141 |
| 1842 | | | | | | | | | | | | | | | | 2,610,057 |
| 1843 | | | | | | | | | | | | | | | | 3,060,874 |
| 1844 | | | | | | | | | | | | | | | | 3,681,252 |
| 1845 | | | | | | | | | | | | | | | | 4,309,904 |

[a] From 1871 to 1888, inclusive, production reported in this column is due principally to colliery consumption, which in some years was estimated and not included in the distribution by States. Since 1888 small, irregular production from several unimportant sources has been included in this column.

*Production of coal in the United States from 1814 to the close of 1907, in short tons*—Continued.

| Year. | Michigan. | Georgia. | California. | West Virginia. | Colorado. | Wyoming. | Kansas. | Utah. | Oklahoma (Ind. T.). | Oregon. | Montana. | New Mexico. | Texas. | North Dakota. | Miscellaneous.[a] | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1846 | | | | | | | | | | | | | | | | 4,865,522 |
| 1847 | | | | | | | | | | | | | | | | 5,286,067 |
| 1848 | | | | | | | | | | | | | | | | 5,773,974 |
| 1849 | | | | | | | | | | | | | | | | 6,448,831 |
| 1850 | | | | | | | | | | | | | | | | 7,018,181 |
| 1851 | | | | | | | | | | | | | | | | 8,734,525 |
| 1852 | | | | | | | | | | | | | | | | 9,816,664 |
| 1853 | | | | | | | | | | | | | | | | 10,570,288 |
| 1854 | | | | | | | | | | | | | | | | 11,977,102 |
| 1855 | | | | | | | | | | | | | | | | 12,926,673 |
| 1856 | | | | | | | | | | | | | | | | 13,546,925 |
| 1857 | | | | | | | | | | | | | | | | 13,340,189 |
| 1858 | | | | | | | | | | | | | | | | 13,974,478 |
| 1859 | | | | | | | | | | | | | | | | 15,633,175 |
| 1860 | 2,320 | 1.900 | | | | | | | | | | | | | 3,800 | 14,610,042 |
| 1861 | 3,000 | 2,500 | 6,620 | | | | | | | | | | | | | 16,488,012 |
| 1862 | 5,000 | 3,500 | 23,400 | | | | | | | | | | | | | 17,485,835 |
| 1863 | 8,000 | 6,000 | 43,200 | 444,648 | | | | | | | | | | | | 21,319,062 |
| 1864 | 12,000 | 10,000 | 50,700 | 454,888 | 500 | | | | | | | | | | | 23,605,123 |
| 1865 | 15,000 | 10,000 | 60,530 | 487,897 | 1,200 | 800 | | | | | | | | | | 23,792,173 |
| 1866 | 20,000 | 8,000 | 84.020 | 512.068 | 6,400 | 2,500 | | | | | | | | | | 29,003,583 |
| 1867 | 25,000 | 8,000 | 124,690 | 589,360 | 17,000 | 5,000 | | | | | | | | | | 30,724,422 |
| 1868 | 28,000 | 10.000 | 143,676 | 609,227 | 10,500 | 6,925 | | | | | | | | | | 32,861,960 |
| 1869 | 29,980 | 12,000 | 157,234 | 603,148 | 8,000 | 49,382 | 36,891 | | | | | | | | | 32,904,360 |
| 1870 | 28.150 | 15,000 | 141,890 | 608,878 | 4,500 | 50,000 | 32,938 | 5,800 | | | | | | | 1,425 | 33,035,580 |
| 1871 | 32,000 | 20,000 | 152,493 | 618,830 | 15,600 | 147,328 | 41,000 | | | | | | | | 5,629,869 | 46,885,080 |
| 1872 | 33,600 | 25,000 | 190,859 | 700,000 | 68,540 | 221,745 | 44,800 | | | | | | | | 176,159 | 51,453,399 |
| 1873 | 56,000 | 40,000 | 186,611 | 1,000,000 | 69,997 | 259.700 | 56,000 | | | | | | | | 1,939,567 | 57,602,480 |
| 1874 | 58,000 | 60,000 | 215,352 | 1,120,000 | 77,372 | 219,061 | 85,000 | | | | | | | | | 52,605,920 |
| 1875 | 62,500 | 80,000 | 166,638 | 1,120 000 | 98,838 | 300,808 | 150,000 | | | | | | | | 40.000 | 52,348,320 |
| 1876 | 66,000 | 110,000 | 128,049 | 896,000 | 117,666 | 334,550 | 225,000 | 50,400 | | | | | | | 366,875 | 53,280,000 |
| 1877 | 69,197 | 120,000 | 107,789 | 1,120,000 | 160,000 | 342,853 | 300,000 | 50,400 | | | | | | | 1,056,734 | 60,501,760 |
| 1878 | 85,322 | 128,000 | 134,237 | 1,120,000 | 200,630 | 333,200 | 375,000 | 67,200 | | | | | | | 374,744 | 57,935,600 |
| 1879 | 82,015 | 140,000 | 147,879 | 1,400,000 | 322,732 | 400,991 | 460,000 | 50,000 | | | | | | | | 68,105,799 |
| 1880 | 100,800 | 154,644 | 236,950 | 1,829,844 | 462,747 | 589,595 | 771,442 | 14,748 | 120,947 | 43,205 | 224 | | | | 200 | 71,481,570 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1881...... | 112,006 | 168,000 | 140,000 | 1,680,000 | 706,744 | 420,000 | 840,000 | 52,000 | 150,000 | 33,600 | 5,000 | .......... | .......... | .......... | 97,900 | 85,881,030 |
| 1882...... | 135,339 | 160,000 | 112,592 | 2,240,000 | 1,061,497 | 707,764 | 750,000 | 100,000 | 200,000 | 35,000 | 10,000 | 157,092 | .......... | .......... | 6,502,359 | 103,551,189 |
| 1883...... | 71,296 | 155,000 | 76,162 | 2,335,833 | 1,229,593 | 779,689 | 900,000 | 200,000 | 350,000 | 40,000 | 19,795 | 211,347 | .......... | .......... | 6,870,075 | 115,707,525 |
| 1884...... | 36,712 | 150,000 | 77,485 | 3,360,000 | 1,130,024 | 902,620 | 1,100,000 | 200,000 | 425,000 | 45,000 | 80,376 | 220,557 | 125,000 | 35,000 | 9,498,174 | 120,155,551 |
| 1885...... | 45,178 | 150,000 | 71,615 | 3,369,062 | 1,356,062 | 807,328 | 1,212,057 | 213,120 | 500,000 | 50,000 | 86,440 | 306,202 | 100,000 | 25,000 | .......... | 111,160,295 |
| 1886...... | 60,434 | 223,000 | 100,000 | 4,005,796 | 1,368.338 | 829,355 | 1,400,000 | 200,000 | 534.580 | 45,000 | 49,846 | 271,285 | 100,000 | 25,955 | 794,917 | 113,680,427 |
| 1887...... | 71,461 | 313,715 | 50,000 | 4,881,620 | 1,791,735 | 1,170,318 | 1,596,879 | 180,021 | 685,911 | 37,696 | 10,202 | 508,034 | 75,000 | 21,470 | 1,237,195 | 130,650,511 |
| 1888...... | 81,407 | 180,000 | 95,000 | 5,498,800 | 2,185,477 | 1,481,540 | 1,850,000 | 258,961 | 761,986 | 75,000 | 41,467 | 626,665 | 90,000 | 34,000 | 4,257,907 | 148,659,657 |
| 1889...... | 67,431 | 225,934 | 119,820 | 6,231,880 | 2,597,181 | 1,388,947 | 2,221,043 | 236,651 | 752,832 | 64,359 | 363,301 | 486,943 | 128,216 | 28,907 | 1,400 | 141,229,513 |
| 1890...... | 74,977 | 228,337 | 110,711 | 7,394,654 | 3,077,003 | 1,870,366 | 2,259,922 | 318,159 | 869,229 | 61,514 | 517,477 | 375,777 | 184,440 | 30,000 | 807 | 157,770,963 |
| 1891...... | 80,307 | 171,000 | 93,301 | 9,220,665 | 3,512,632 | 2,327,841 | 2,716,705 | 371,045 | 1,091,032 | 51,826 | 541,861 | 462,328 | 172,100 | 30,000 | 2,000 | 168,566,669 |
| 1892...... | 77,990 | 215,498 | 85,178 | 9,738,755 | 3,510,830 | 2,503,839 | 3,007,276 | 361,013 | 1,192,721 | 34,661 | 564,648 | 661,330 | 245,690 | 40,725 | 1,500 | 179,329,071 |
| 1893...... | 45,979 | 372,740 | 72,603 | 10,708,578 | 4,102,389 | 2,439,311 | 2,652,546 | 413,205 | 1,252,110 | 41,683 | 892,309 | 665,094 | 302,206 | 49,630 | .......... | 182,352,774 |
| 1894...... | 70,022 | 354,111 | 67,247 | 11,627,757 | 2,831,409 | 2,417,463 | 3,388,251 | 431,550 | 969,606 | 47,521 | 927,395 | 597,196 | 420,848 | 42,015 | 150 | 170,741,526 |
| 1895...... | 112,322 | 260,998 | 75,453 | 11,387,961 | 3,082,982 | 2,246,911 | 2,926,870 | 471,836 | 1,211,185 | 73,685 | 1,504,193 | 720,654 | 484,959 | 38,997 | 200 | 193,117,530 |
| 1896...... | 92,882 | 238,546 | 78,544 | 12,876,296 | 3,112,400 | 2,229,624 | 2,884,801 | 418,627 | 1,366,646 | 101,721 | 1,543,445 | 622,626 | 544,015 | 78,050 | 18,792 | 191,986,357 |
| 1897...... | 223,592 | 195,869 | 87,992 | 14,248,159 | 3,361,703 | 2,597,886 | 3,054,012 | 521,560 | 1,336,380 | 107,289 | 1,647,882 | 716,981 | 639,341 | 77,246 | 18,565 | 200,229,199 |
| 1898...... | 315,722 | 244,187 | 145,888 | 16,700,999 | 4,076,347 | 2,863,812 | 3,406,555 | 593,709 | 1,381,466 | 58,184 | 1,479,803 | 992,288 | 686,734 | 83,895 | 17,039 | 219,976,267 |
| 1899...... | 624,708 | 233,111 | 160,915 | 19,252,995 | 4,776,224 | 3,837,392 | 3,852,267 | 786,049 | 1,537,427 | 86,888 | 1,496,451 | 1,050,714 | 883,832 | 98,809 | 1,277 | 253,741,192 |
| 1900...... | 849,475 | 315,557 | 171,708 | 22,647,207 | 5,244,364 | 4,014,602 | 4,467,870 | 1,147,027 | 1,922,298 | 58,864 | 1,661,775 | 1,299,299 | 968,373 | 129,883 | 1,210 | 269,684,027 |
| 1901...... | 1,241,241 | 342,825 | 151,079 | 24,068,402 | 5,700,015 | 4,485,374 | 4,900,528 | 1,322,614 | 2,421,781 | 69,011 | 1,396,081 | 1,086.546 | 1,107,953 | 166,601 | 1,300 | 293,299,816 |
| 1902...... | 964,718 | 414,083 | 84,984 | 24,570,826 | 7,401,343 | 4,429,491 | 5,266,065 | 1,574,521 | 2,820,666 | 65,648 | 1,560,823 | 1,048,763 | 901,912 | 226,511 | 4,242 | 301,590,439 |
| 1903...... | 1,367,619 | 416,951 | 104,673 | 29,337,241 | 7,423,602 | 4,635,293 | 5,839,976 | 1,681,409 | 3,517,388 | 91,144 | 1,488,810 | 1,541,781 | 926,759 | 278,645 | 4,997 | 357,356,416 |
| 1904...... | 1,342,840 | 383,191 | 78,888 | 32,406,752 | 6,658,355 | 5,178,556 | 6,333,307 | 1,493,027 | 3,046,539 | 111,540 | 1,358,919 | 1,452.325 | 1,195,944 | 271,928 | 4,174 | 351,816,398 |
| 1905...... | 1,473,211 | 351,991 | 77,050 | 37,791,580 | 8,826,429 | 5,602,021 | 6,423,979 | 1,332,372 | 2,924,427 | 109,641 | 1,643,832 | 1,649,933 | 1,200,684 | 317,542 | 9,656 | 392,722,635 |
| 1906...... | 1,346,338 | 332,107 | 25,290 | 43,290,350 | 10,111,218 | 6,133,994 | 6,024,775 | 1,772,551 | 2,860,200 | 79,731 | 1,829,921 | 1,964,713 | 1,312,873 | 305,689 | 11,706 | 414,157,278 |
| 1907...... | 2,035,858 | 362,401 | 13,950 | 48,091,583 | 10,790,236 | 6,252,990 | 7,322,449 | 1,947,607 | 3,642,658 | 70,981 | 2,016,857 | 2,628,959 | 1,648,069 | 347,760 | 17,727 | 480,363,424 |
| Total.. | 13,842,943 | 8,123,696 | 5,030,945 | 434,198,539 | 112,668,336 | 77,818,765 | 91,176,204 | 18,837,182 | 39,845,015 | 1,790,392 | 24,739,133 | 22,325,432 | 14,444,948 | 2,784,258 | 38,966,162 | 6,865,097,567 |

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[a] From 1871 to 1888, inclusive, production reported in this column is due principally to colliery consumption, which in some years was estimated and not included in the distribution by States. Since 1888 small, irregular production from several unimportant sources has been included in this column.

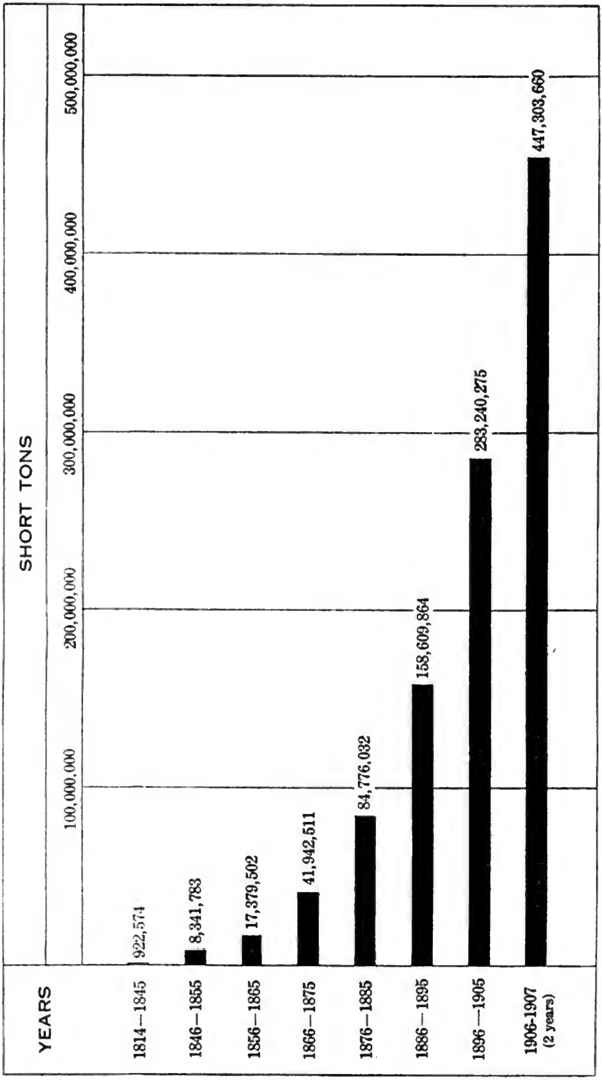

FIG. 3.—Average yearly production of coal for each decade in the United States since 1814, in short tons.

## COAL FIELDS OF THE UNITED STATES.

The coal areas of the United States are divided, for the sake of convenience, into two great divisions—anthracite and bituminous.

The areas in which anthracite is produced are confined almost exclusively to the eastern part of Pennsylvania, and usually when the anthracite fields of the United States are referred to those of eastern Pennsylvania are considered. This region is included in the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan, and underlies an area of about 480 square miles. In addition to these well-known anthracite fields of Pennsylvania there are two small areas in the Rocky Mountain region where the coal has been locally anthracited, although the production from these districts has never amounted to as much as 100,000 tons in any one year. One of these localities is in Gunnison County, Colo., and the other in Santa Fe County, N. Mex. The coal, although only locally metamorphosed, is a true anthracite and of a good quality. In previous years some coal which was classed as anthracite was mined and sold in New England. The productive area was confined to the eastern part of Rhode Island and the counties of Bristol and Plymouth, in Massachusetts. This product, however, is in reality a graphitic and not an anthracite coal, and is no longer mined for fuel purposes. The production in the last few years has been included with the graphite production.

The bituminous and lignite fields are scattered widely over the United States and include an area of something over 496,000 square miles. The previous classification of these coal areas as published in earlier volumes of Mineral Resources of the United States has been changed as a result of conferences among the geologists working under Mr. M. R. Campbell in the economic geology of coal. The areas are divided, primarily, into 6 provinces, as follows:

(1) The Eastern province, which includes all of the bituminous areas of the Appalachian region; the Atlantic Coast region, which includes the Triassic fields near Richmond and the Deep and Dan rivers fields of North Carolina, and also the anthracite region of Pennsylvania. (2) The Gulf province, which includes the lignite fields of Alabama, Mississippi, Louisiana, Arkansas, and Texas. (3) The Interior province, which includes all the bituminous areas of the Mississippi Valley region and the coal fields of Michigan. This province is subdivided into the Eastern region, which embraces the coal fields of Illinois, Indiana, and western Kentucky; the Western region, which includes the fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma; and the Southwestern region, which includes the coal fields of Texas. The Michigan fields are designated as the Northern region of the Interior province. (4) The Northern, or Great Plains, province, which includes the lignite areas of North and South Dakota and the bituminous and subbituminous areas of northeastern Wyoming and northern and eastern Montana. (5) The Rocky Mountain province, which includes the coal fields of the portions of Montana and Wyoming which are in the mountainous districts of those States, and all the coal fields of Utah, Colorado, and New Mexico. (6) The Pacific Coast province, which includes all of the coal fields of California, Oregon, and Washington.

A map of the coal fields of the United States, so far as known to the close of 1907, prepared by Mr. M. R. Campbell, is presented herewith, together with an explanation of the map, a statement regarding the character and geologic age of the coal, and the estimated tonnage of the various fields. It will be noted that Mr. Campbell estimates the total original supply at 3,157,243,000,000 short tons, of which 2,004,018,000,000 short tons are easily accessible, and 1,153,225,000,000 short tons are accessible with difficulty. The total production of the United States to the close of 1907 was 6,865,097,567 short tons, which represented, including the waste involved in the mining and preparation of coal, an exhaustion of 10,218,000,000 tons, leaving still available 1,993,800,000,000 tons of easily accessible coal, or 3,147,025,000,000 tons including that which is accessible with difficulty. The quantity of easily accessible coal left in the ground at the close of 1907 was 4,150 times the production for that year, and 2,870 times the exhaustion represented by the production of last year.

Brief descriptions of the coal fields of each State are given in the subsequent pages in connection with the discussion of the production by States. For a more extended description of the coal-producing areas of the United States, the reader is referred to the Twenty-second Annual Report of the United States Geological Survey, Part III.

*Coal fields of the United States and their production, 1903–1907.*

| | Area.[a] | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| *Anthracite.* | *Sq. miles.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Pennsylvania | 480 | 74,607,068 | 73,156,709 | 77,659,850 | 71,282,411 | 85,604,312 |
| Colorado and New Mexico | 29 | 72,731 | 72,074 | 74,823 | [b] 60,248 | 62,092 |
| Total | 509 | 74,679,799 | 73,228,783 | 77,734,673 | 71,342,659 | 85,666,404 |
| *Bituminous.*[c] | | | | | | |
| Eastern Province. | | | | | | |
| Atlantic Coast Region: | | | | | | |
| Virginia | 150 | 18,084 | 2,100 | ........ | ........ | ........ |
| North Carolina | 60 | 17,309 | 7,000 | 1,557 | ........ | ........ |
| Appalachian Region: | | | | | | |
| Pennsylvania | 14,200 | 103,117,178 | 97,938,287 | 118,413,637 | 129,293,206 | 150,143,177 |
| Ohio | 12,660 | 24,838,103 | 24,400,220 | 25,552,950 | 27,731,640 | 32,142,419 |
| Maryland | 455 | 4,846,165 | 4,813,622 | 5,108,539 | 5,435,453 | 5,532,628 |
| Virginia | 1,750 | 3,433,223 | 3,408,814 | 4,275,271 | 4,254,879 | 4,710,895 |
| West Virginia | 17,000 | 29,337,241 | 32,406,752 | 37,791,580 | 43,290,350 | 48,091,583 |
| Eastern Kentucky | 10,270 | 3,158,972 | 3,211,418 | 3,506,597 | 3,768,651 | 4,457,727 |
| Tennessee | 4,400 | 4,798,004 | 4,782,211 | 5,766,690 | 6,250,275 | 6,810,243 |
| Georgia | 167 | 416,951 | 383,191 | 351,991 | 332,107 | 362,401 |
| Alabama | 8,430 | 11,654,324 | 11,262,046 | 11,866,069 | 13,107,963 | 14,250,454 |
| Total | 69,332 | 185,000,161 | 182,606,561 | 212,633,324 | 233,473,524 | 266,501,527 |
| Interior Province. | | | | | | |
| Northern Region: | | | | | | |
| Michigan | 11,000 | 1,367,619 | 1,342,840 | 1,473,211 | 1,346,338 | 2,035,858 |
| Eastern Region: | | | | | | |
| Indiana | 6,500 | 10,794,692 | 10,842,189 | 11,895,252 | 12,092,560 | 13,985,713 |
| Western Kentucky | 6,400 | 4,379,000 | 4,365,064 | 4,925,926 | 5,884,996 | 6,295,397 |
| Illinois | 35,600 | 36,957,104 | 36,475,060 | 38,434,363 | 41,480,104 | 51,317,146 |
| Total | 48,500 | 52,130,856 | 51,682,313 | 55,255,541 | 59,457,660 | 71,598,256 |

[a] Known to contain workable coal.

[b] Colorado only.

[c] Includes brown coal or lignite, semianthracite, semibituminous, etc., and scattering lots of anthracite.

*Coal fields of the United States and their production, 1903–1907*—Continued.

| | Area. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| *Bituminous*—Continued. | | | | | | |
| Interior Province—Continued. | | | | | | |
| Western and Southwestern Regions:[a] | *Sq. miles.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Iowa | 12,560 | 6,419,811 | 6,519,933 | 6,798,609 | 7,266,224 | 7,574,322 |
| Missouri | 16,700 | 4,238,586 | 4,168,308 | 3,983,378 | 3,758,008 | 3,997,936 |
| Nebraska | 3,200 | | | | | 750 |
| Kansas | 3,100 | 5,839,976 | 6,333,307 | 6,423,979 | 6,024,775 | 7,322,449 |
| Arkansas | 1,684 | 2,229,172 | 2,009,451 | 1,934,673 | 1,864,268 | 2,670,438 |
| Oklahoma (Ind. Ter.) | 10,000 | 3,517,388 | 3,046,539 | 2,924,427 | 2,860,200 | 3,642,658 |
| Texas | 10,200 | 926,759 | 1,195,944 | 1,200,684 | 1,312,873 | 1,648,069 |
| Total | 57,444 | 23,171,692 | 23,273,482 | 23,265,750 | 23,086,348 | 26,856,622 |
| Rocky Mountain and Northern Great Plains Provinces. | | | | | | |
| North Dakota | 31,240 | 278,645 | 271,928 | 317,542 | 305,689 | 347,760 |
| Montana | 34,067 | 1,488,810 | 1,358,919 | 1,643,832 | 1,829,921 | 2,016,857 |
| Wyoming | 20,568 | 4,635,293 | 5,178,556 | 5,602,021 | 6,133,994 | 6,252,990 |
| Utah | 13,130 | 1,681,409 | 1,493,027 | 1,332,372 | 1,772,551 | 1,947,607 |
| Colorado | 10,105 | 7,381,463 | 6,610,110 | 8,776,021 | 10,050,970 | 10,748,014 |
| New Mexico | 13,331 | 1,511,189 | 1,428,496 | 1,625,518 | 1,964,713 | 2,609,089 |
| Idaho | 200 | 4,250 | 3,330 | 5,782 | 5,365 | 6,508 |
| Nevada | | | 150 | 100 | 800 | 330 |
| Total | 122,441 | 16,981,059 | 16,344,516 | 19,303,188 | 22,064,003 | 23,929,155 |
| Pacific Coast Province and Alaska. | | | | | | |
| Washington | 1,100 | 3,193,273 | 3,137,681 | 2,864,926 | 3,276,184 | 3,680,532 |
| Oregon | 230 | 91,144 | 111,540 | 109,641 | 79,731 | 70,981 |
| California | 500 | 104,673 | 78,888 | 77,050 | 25,290 | 13,950 |
| Alaska | | 747 | 694 | 3,774 | 5,541 | 10,139 |
| Total | 1,830 | 3,389,837 | 3,328,803 | 3,055,391 | 3,386,746 | 3,775,602 |
| Total production, including colliery consumption | | 357,356,416 | 351,816,398 | 392,722,635 | 414,157,278 | 480,363,424 |

[a] Including Texas lignite fields of Gulf Province.

*Total production of each region, 1887–1907, in short tons.*

| | Anthracite. | Bituminous. | | |
|---|---|---|---|---|
| | | Atlantic coast. | Appalachian. | Northern. |
| Area [a] ........ square miles.. | [b] 519 | 210 | 69,332 | 11,000 |
| *Year.* | | | | |
| 1887 | 39,548,255 | 30,000 | 55,888,088 | 71,461 |
| 1888 | 43,971,688 | 33,000 | 60,966,245 | 81,407 |
| 1889 | 45,600,487 | 49,633 | 62,972,222 | 67,431 |
| 1890 | 46,468,641 | 29,608 | 73,008,102 | 74,977 |
| 1891 | 50,665,931 | 37,645 | 77,984,563 | 80,307 |
| 1892 | 52,537,467 | 43,889 | 83,122,190 | 77,990 |
| 1893 | 54,061,121 | 36,878 | 81,207,168 | 45,979 |
| 1894 | 51,992,671 | 68,979 | 76,278,748 | 70,002 |
| 1895 | 58,066,516 | 82,682 | 90,167,596 | 112,322 |
| 1896 | 54,425,573 | 103,483 | 90,748,305 | 92,882 |
| 1897 | 52,680,756 | 116,950 | 97,128,220 | 223,592 |
| 1898 | 53,429,739 | 38,938 | 114,239,156 | 315,722 |
| 1899 | 60,514,201 | 28,353 | 129,843,906 | 624,708 |
| 1900 | 57,466,319 | 57,912 | 142,298,208 | 849,475 |
| 1901 | 67.538,536 | 12.000 | 150,501,214 | 1,241,241 |
| 1902 | 41,467,532 | 39,206 | 173,274,861 | 964,718 |
| 1903 | 74,679,799 | 35,393 | 185,600,161 | 1,367,619 |
| 1904 | 73,228,783 | 9,100 | 182,606,561 | 1,342,840 |
| 1905 | 77,734,673 | 1,557 | 212,633,324 | 1,473,211 |
| 1906 | 71,342,659 | ............ | 233,473,524 | 1,346,338 |
| 1907 | 85,666,404 | ............ | 266,501,527 | 2,035,858 |

| | Bituminous. | | | |
|---|---|---|---|---|
| | Eastern. | Western and South-western. | Rocky Mountain, etc. | Pacific coast and Alaska. |
| Area [a] ........ square miles.. | 48,500 | 57,444 | 122,441 | 1,830 |
| *Year.* | | | | |
| 1887 | 14,478,883 | 10,172,634 | 3,646,280 | 854,308 |
| 1888 | 19,173,167 | 11,842,764 | 4,583,719 | 1,385,750 |
| 1889 | 16,240,314 | 10,036,356 | 5,048,413 | 1,214,757 |
| 1890 | 20,075,840 | 10,470,439 | 6,205,782 | 1,435,914 |
| 1891 | 20,327,323 | 11,023,817 | 7,245,707 | 1,201,376 |
| 1892 | 23,001,653 | 11,635,185 | 7,577,422 | 1,333,266 |
| 1893 | 25,502,809 | 11,651,296 | 8,468,360 | 1,379,163 |
| 1894 | 22,430,617 | 11,503,623 | 7,175,628 | 1,221,238 |
| 1895 | 23,599,469 | 11,749,803 | 7,998,594 | 1,340,548 |
| 1896 | 25,539,867 | 11,750,966 | 7,925,280 | 1,391,001 |
| 1897 | 26,414,127 | 13,164,059 | 8,854,182 | 1,641,779 |
| 1898 | 25,816,874 | 13,988,436 | 10,042,759 | 2,104,643 |
| 1899 | 33,181,247 | 15,320,373 | 11,949,463 | 2,278,941 |
| 1900 | 35,358,164 | 17,549,528 | 13,398,556 | 2,705,865 |
| 1901 | 37,450,871 | 19,665,985 | 14,090,362 | 2,799,607 |
| 1902 | 46,133,024 | 20,727,495 | 16,149,545 | 2,834,058 |
| 1903 | 52,130,856 | 23,171,692 | 16,981,059 | 3,389,837 |
| 1904 | 51,682,313 | 23,273,482 | 16,344,516 | 3,328,803 |
| 1905 | 55,255,541 | 23,265,750 | 19,303,188 | 3,055,391 |
| 1906 | 59,457,660 | 23,086,348 | 22,064,003 | 3,386,746 |
| 1907 | 71,598,256 | 26,856,622 | 23,929,155 | 3,775,602 |

[a] Known to contain workable coal.
[b] Includes 29 square miles in Colorado and New Mexico.

The following table shows how the production in each of the six principal bituminous areas has developed since 1887 and how the percentages of the total produced by each during the last five years compare with one another. From this table it appears that the percentage of the total produced in the Appalachian district had increased from 63.11 in 1887 to 68.1 in 1906, and decreased to 67.51 in 1907. The Eastern region of the Interior Province increased its percentage of the total from 16.50 in 1887 to 18.13 in 1907, and the Rocky Mountain region from 4.15 in 1887 to 6.44 in 1906, and decreased to 6.06 in 1907. The Western region of the Interior Province, which in 1887 contributed 11.49 per cent, produced only 6.80 per cent in 1907.

*Production of the six principal bituminous coal regions in 1887, 1903, 1904, 1905, 1906, and 1907, compared, in short tons.*

| Region. | 1887. | | 1903. | | 1904. | | 1905. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Percentage of total. | Quantity. | Percentage of total. | Quantity. | Percentage of total. | Quantity. | Percentage of total. |
| Appalachian | 55,888,088 | 63.11 | 185,600,161 | 65.64 | 182,606,561 | 65.53 | 212,633,324 | 67.49 |
| Eastern | 14,478,883 | 16.50 | 52,130,856 | 18.43 | 51,682,313 | 18.55 | 55,255,541 | 17.54 |
| Western | 10,172,634 | 11.49 | 23,171,692 | 8.20 | 23,273,482 | 8.35 | 23,265,750 | 7.38 |
| Northern | 71,461 | .08 | 1,367,619 | .48 | 1,342,840 | .48 | 1,473,211 | .47 |
| Rocky Mountain | 3,646,280 | 4.15 | 16,981,059 | 6.01 | 16,344,516 | 5.87 | 19,303,188 | 6.13 |
| Pacific coast | 854,308 | 1.00 | 3,389,837 | 1.20 | 3,328,803 | 1.19 | 3,055,391 | .97 |

| Region. | 1906. | | 1907. | | Increase in 1907 over 1887. | | Increase in 1907 over 1906. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Percentage of total. | Quantity. | Percentage of total. | Quantity. | Percentage. | Quantity. | Percentage. |
| Appalachian | 233,473,524 | 68.10 | 266,501,527 | 67.51 | 210,613,439 | 376.85 | 33,028,003 | 14.15 |
| Eastern | 59,457,660 | 17.34 | 71,598,256 | 18.13 | 57,119,373 | 394.50 | 12,140,596 | 20.42 |
| Western | 23,086,348 | 6.73 | 26,856,622 | 6.80 | 16,683,988 | 164.01 | 3,770,274 | 16.33 |
| Northern | 1,346,338 | .39 | 2,035,858 | .52 | 1,964,397 | 2,748.91 | 689,520 | 51.21 |
| Rocky Mountain | 22,064,003 | 6.44 | 23,929,155 | 6.06 | 20,282,875 | 556.26 | 1,865,152 | 8.45 |
| Pacific coast | 3,386,746 | .99 | 3,775,602 | .96 | 2,921,294 | 341.95 | 388,856 | 11.48 |

## RANK OF COAL-PRODUCING STATES.

In the following tables the coal-producing States are arranged according to rank in 1906 and 1907, first in the quantity of coal produced and then according to the value of the product, with the percentage of both quantity and value contributed by each State.

It will be noted that West Virginia, which in 1906 supplanted Illinois as second in rank, dropped back to third place in 1907. The suspension of mining operations in the spring of 1906 was general throughout the coal-producing districts of Illinois, and affected West Virginia but little, giving the latter State the lead over Illinois of 1,810,246 tons. In 1907, with peace reigning generally throughout the coal-mining regions, Illinois's production increased 9,837,042 short tons, whereas West Virginia showed an increase of only 4,801,233 short tons, so that Illinois in 1907 led West Virginia by 3,225,563 tons. These two States will probably be rivals for second place for some years to come. Ohio continued to rank fourth, and Alabama, Indiana, Colorado, Kentucky, and Iowa maintained the same relative ranks as they did in 1906. Kansas, however, has advanced from twelfth to tenth place, supplanting both Tennessee and Wyoming. The record for 1907 showed that the combined production of anthracite and bituminous coal in Pennsylvania amounted to 49.1 per cent of the total in quantity and 51.9 per cent in value. Illinois's production represented 10.7 per cent of the total in quantity and 8.9 per cent in value. West Virginia contributed 10 per cent in quantity and 7.8 per cent in value, and Ohio 6.7 per cent in quantity and 5.7 per cent in value. None of the other States produced as much as 5 per cent of the total.

*Rank of coal-producing States in 1906, with quantity and value of product and percentage of each.*

| Production. | | | | Value. | | | |
|---|---|---|---|---|---|---|---|
| Rank. | State or Territory. | Quantity (short tons). | Percentage of total production. | Rank. | State or Territory. | Value. | Percentage of total value. |
| | Pennsylvania: | | | | Pennsylvania: | | |
| 1 | Anthracite | 71,282,411 | 17.2 | 1 | Anthracite | $131,917,694 | 25.7 |
| | Bituminous | 129,293,206 | 31.2 | | Bituminous | 130,290,651 | 25.4 |
| 2 | West Virginia | 43,290,350 | 10.5 | 2 | Illinois | 44,763,062 | 8.7 |
| 3 | Illinois | 41,480,104 | 10.0 | 3 | West Virginia | 41,051,939 | 8.0 |
| 4 | Ohio | 27,731,640 | 6.7 | 4 | Ohio | 30,346,580 | 5.9 |
| 5 | Alabama | 13,107,963 | 3.2 | 5 | Alabama | 17,514,786 | 3.4 |
| 6 | Indiana | 12,092,560 | 2.9 | 6 | Indiana | 13,116,261 | 2.6 |
| 7 | Colorado | 10,111,218 | 2.4 | 7 | Colorado | 12,735,616 | 2.4 |
| 8 | Kentucky | 9,653,647 | 2.3 | 8 | Iowa | 11,619,455 | 2.3 |
| 9 | Iowa | 7,266,224 | 1.8 | 9 | Kentucky | 9,809,938 | 1.9 |
| 10 | Tennessee | 6,259,275 | 1.5 | 10 | Kansas | 8,979,553 | 1.7 |
| 11 | Wyoming | 6,133,994 | 1.5 | 11 | Wyoming | 8,013,528 | 1.6 |
| 12 | Kansas | 6,024,775 | 1.5 | 12 | Tennessee | 7,667,415 | 1.5 |
| 13 | Maryland | 5,435,453 | 1.3 | 13 | Maryland | 6,474,793 | 1.3 |
| 14 | Virginia | 4,254,879 | 1.0 | 14 | Missouri | 6,118,733 | 1.2 |
| 15 | Missouri | 3,758,008 | .9 | 15 | Washington | 5,908,434 | 1.1 |
| 16 | Washington | 3,276,184 | .8 | 16 | Indian Territory | 5,482,366 | 1.1 |
| 17 | Indian Territory | 2,860,200 | .7 | 17 | Virginia | 4,183,991 | .8 |
| 18 | New Mexico | 1,964,713 | .5 | 18 | Montana | 3,240,357 | .6 |
| 19 | Arkansas | 1,864,268 | .5 | 19 | Arkansas | 3,000,339 | .6 |
| 20 | Montana | 1,829,921 | .4 | 20 | New Mexico | 2,638,986 | .5 |
| 21 | Utah | 1,772,551 | .4 | 21 | Michigan | 2,427,404 | .5 |
| 22 | Michigan | 1,346,338 | .3 | 22 | Utah | 2,408,381 | .5 |
| 23 | Texas | 1,312,873 | .3 | 23 | Texas | 2,178,901 | .4 |
| 24 | Georgia | 332,107 | .1 | 24 | North Dakota | 451,382 | .1 |
| 25 | North Dakota | 305,689 | .1 | 25 | Georgia | 424,004 | .1 |
| 26 | Oregon | 79,731 | | 26 | Oregon | 212,338 | .1 |
| 27 | California and Alaska | 30,831 | | 27 | California and Alaska | 78,684 | |
| 28 | Idaho | [a] 6,165 | | 28 | Idaho | [a] 24,238 | |
| | Total | 414,157,278 | 100.0 | | Total | 513,079,809 | 100.0 |

[a] Includes production of Nevada.

*Rank of coal-producing States in 1907, with quantity and value of product and percentage of each.*

| Production. | | | | Value. | | | |
|---|---|---|---|---|---|---|---|
| Rank. | State or Territory. | Quantity (short tons). | Percentage of total production. | Rank. | State or Territory. | Value. | Percentage of total value. |
| 1 | Pennsylvania: | | | 1 | Pennsylvania: | | |
| | Anthracite | 85,604,312 | 17.8 | | Anthracite | $163,584,056 | 26.6 |
| | Bituminous | 150,143,177 | 31.3 | | Bituminous | 155,664,026 | 25.3 |
| 2 | Illinois | 51,317,146 | 10.7 | 2 | Illinois | 54,687,382 | 8.9 |
| 3 | West Virginia | 48,091,583 | 10.0 | 3 | West Virginia | 47,846,630 | 7.8 |
| 4 | Ohio | 32,142,419 | 6.7 | 4 | Ohio | 35,324,746 | 5.7 |
| 5 | Alabama | 14,250,454 | 3.0 | 5 | Alabama | 18,405,468 | 3.0 |
| 6 | Indiana | 13,985,713 | 2.9 | 6 | Indiana | 15,114,300 | 2.5 |
| 7 | Colorado | 10,790,236 | 2.2 | 7 | Colorado | 15,079,449 | 2.4 |
| 8 | Kentucky | 10,753,124 | 2.2 | 8 | Iowa | 12,258,012 | 2.0 |
| 9 | Iowa | 7,574,322 | 1.6 | 9 | Kentucky | 11,405,038 | 1.9 |
| 10 | Kansas | 7,322,449 | 1.5 | 10 | Kansas | 11,159,698 | 1.8 |
| 11 | Tennessee | 6,810,243 | 1.4 | 11 | Wyoming | 9,732,668 | 1.6 |
| 12 | Wyoming | 6,252,990 | 1.3 | 12 | Tennessee | 8,490,334 | 1.4 |
| 13 | Maryland | 5,532,628 | 1.2 | 13 | Washington | 7,679,801 | 1.2 |
| 14 | Virginia | 4,710,895 | 1.0 | 14 | Oklahoma (Indian Territory) | 7,433,914 | 1.2 |
| 15 | Missouri | 3,997,936 | .8 | 15 | Maryland | 6,623,697 | 1.1 |
| 16 | Washington | 3,680,532 | .8 | 16 | Missouri | 6,540,709 | 1.1 |
| 17 | Oklahoma (Indian Territory) | 3,642,658 | .8 | 17 | Virginia | 4,807,533 | .8 |
| 18 | Arkansas | 2,670,438 | .6 | 18 | Arkansas | 4,473,693 | .7 |
| 19 | New Mexico | 2,628,959 | .5 | 19 | Montana | 3,907,082 | .6 |
| 20 | Michigan | 2,035,858 | .4 | 20 | New Mexico | 3,832,128 | .6 |
| 21 | Montana | 2,016,857 | .4 | 21 | Michigan | 3,660,833 | .6 |
| 22 | Utah | 1,947,607 | .4 | 22 | Utah | 2,959,769 | .5 |
| 23 | Texas | 1,648,069 | .3 | 23 | Texas | 2,778,811 | .4 |
| 24 | Georgia | 362,401 | .1 | 24 | North Dakota | 560,199 | .1 |
| 25 | North Dakota | 347,760 | .1 | 25 | Georgia | 499,686 | .1 |
| 26 | Oregon | 70,981 | | 26 | Oregon | 166,304 | .1 |
| 27 | California and Alaska | 24,089 | | 27 | California and Alaska | 91,813 | |
| 28 | Idaho | [a] 7,588 | | 28 | Idaho | [a] 31,119 | |
| | Total | 480,363,424 | 100.0 | | Total | 614,798,898 | 100.0 |

[a] Includes production of Nebraska and Nevada.

## KINDS OF COAL PRODUCED IN THE UNITED STATES.

In the general discussion of the coal production of the United States, only two divisions are considered, anthracite and bituminous, the latter product including the small anthracite output of Colorado and New Mexico. In the bituminous production, however, in addition to the small Rocky Mountain output of anthracite is also included the production of coals generally classed as semianthracite, semibituminous, cannel, block, splint, and lignite or subbituminous. In the following table the production of these varieties of coal in 1906 and 1907 is reported as prepared from the schedules returned to the Survey. It should be stated, however, that this classification makes no claim to technical exactness. It has been compiled from the replies of the producers to the inquiry "Kind of coal produced" on the schedules, and such replies are in some minor cases based on quite uncertain knowledge. It is believed, however, that in this classification the quantity of each kind of coal produced is approximately indicated. It is sufficiently correct for practical purposes and shows that in addition to the production of anthracite in Pennsylvania there were 42,222 tons of anthracite mined in Colorado and 19,870 tons in New Mexico. Semianthracite coal is reported from Virginia, Oklahoma, and Arkansas, the semianthracite production of the Bernice Basin in Pennsylvania having been included in the anthracite. Bituminous coal was produced in 26 States and Territories, and forms by large odds the greater part of the total production. Semibituminous coal is produced in 15 States, West Virginia leading, with Pennsylvania second, Maryland third, Wyoming fourth, and Colorado fifth. Wyoming leads in the production of lignite or subbituminous coal, more than 50 per cent of the total production of this kind of coal in 1907 being from Wyoming. Nearly 70 per cent of the State's production is classed as lignite or subbituminous coal. It should be stated in this connection that the classification of what was formerly called "black lignite" of the Rocky Mountain States is erroneous, as it is entirely distinct from the true lignites or brown coals. These coals are not lignites in chemical composition, in color, or in physical characteristics. They lie between the lignites or brown coals and the true bituminous coals, and in order that a proper distinction may be made the term "subbituminous" has been adopted by the Geological Survey as properly applicable to them. It is in this variety of coal that Wyoming leads, Colorado coming second and New Mexico third. A part of the California and Oregon product should also be included under the head of subbituminous. The principal producers of true lignites or brown coals are Texas and North Dakota. The comparatively small production of cannel coal was obtained from 9 States in 1907, Kentucky leading, with Indiana second and Pennsylvania third. West Virginia is credited with over 96 per cent of the production of splint coal, while 80 per cent of the block coal is produced in Indiana.

*Classification of the coal product of the United States in 1906, by States and Territories, in short tons.*

| State or Territory. | Bituminous. | Anthracite. | Semi-bituminous. | Lignite and subbituminous. | Semi-anthracite. | Block. | Splint. | Cannel. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Pennsylvania | 126,153,741 | 71,282,411 | 3,133,305 | | | | | 6,160 | 200,575,617 |
| West Virginia | 33,923,554 | | 5,422,422 | | | | 3,929,894 | 14,480 | 43,290,350 |
| Illinois | 41,480,104 | | | | | | | | 41,480,104 |
| Ohio | 27,679,846 | | 37,458 | | | 10,500 | | 3,836 | 27,731,640 |
| Alabama | 13,107,963 | | | | | | | | 13,107,963 |
| Indiana | 11,267,194 | | | | | [a] 799,891 | | 25,475 | 12,092,560 |
| Colorado | 8,095,279 | 60,248 | 399,695 | 1,555,996 | | | | | 10,111,218 |
| Kentucky | 9,345,274 | | 9,893 | | | 12,000 | 208,747 | [b] 77,733 | 9,653,647 |
| Iowa | 7,200,519 | | | | | 52,685 | | 13,020 | 7,266,224 |
| Tennessee | 6,148,064 | | 111,211 | | | | | | 6,259,275 |
| Wyoming | 1,317,974 | | 421,680 | 4,394,340 | | | | | 6,133,994 |
| Kansas | 6,022,175 | | | 2,600 | | | | | 6,024,775 |
| Maryland | 4,035,987 | | 1,399,466 | | | | | | 5,435,453 |
| Virginia | 3,427,486 | | 778,653 | | 48,740 | | | | 4,254,879 |
| Missouri | 3,731,183 | | | | | 21,725 | | 5,100 | 3,758,008 |
| Washington | 2,909,706 | | 204,165 | 162,313 | | | | | 3,276,184 |
| Indian Territory | 2,771,211 | | 5,119 | | 83,870 | | | | 2,860,200 |
| New Mexico | 1,416,726 | | | 547,987 | | | | | 1,964,713 |
| Arkansas | 1,180,873 | | 84,607 | | 598,788 | | | | 1,864,268 |
| Montana | 1,163,328 | | 646,381 | 19,562 | 650 | | | | 1,829,921 |
| Utah | 1,735,809 | | 1,325 | 35,417 | | | | | 1,772,551 |
| Michigan | 1,346,338 | | | | | | | | 1,346,338 |
| Texas | 839,985 | | | 472,888 | | | | | 1,312,873 |
| Georgia | 95,096 | | 237,011 | | | | | | 332,107 |
| North Dakota | | | | 305,689 | | | | | 305,689 |
| Oregon | | | | 79,731 | | | | | 79,731 |
| California | | | 3,090 | 22,200 | | | | | 25,290 |
| Idaho [c] | | | | 6,165 | | | | | 6,165 |
| Alaska | | | | 5,541 | | | | | 5,541 |
| Total | 316,395,415 | 71,342,659 | 12,895,481 | 7,610,429 | 732,048 | 896,801 | 4,138,641 | 145,804 | 414,157,278 |

[a] Includes 23,325 tons of semiblock coal.

[b] Includes 4,650 tons of semicannel coal

[c] Includes Nevada's production.

*Classification of the coal product of the United States in 1907, by States and Territories, in short tons.*

| State or Territory. | Bituminous. | Anthracite. | Semi-bituminous. | Lignite and subbituminous. | Semi-anthracite. | Block. | Splint. | Cannel. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Pennsylvania | 145,678,526 | 85,604,312 | 4,432,514 | | | 17,365 | | 14,772 | 235,747,489 |
| Illinois | 51,317,146 | | | | | | | | 51,317,146 |
| West Virginia | 38,222,196 | | 4,634,755 | | | 59,636 | [a] 5,161,315 | 13,681 | 48,091,583 |
| Ohio | 32,129,834 | | | | | 12,185 | | 400 | 32,142,419 |
| Alabama | 14,235,232 | | 500 | | | | | 14,722 | 14,250,454 |
| Indiana | 13,087,844 | | | | | [b] 857,214 | | [c] 40,655 | 13,985,713 |
| Colorado | 8,288,306 | 42,222 | 666,954 | 1,792,754 | | | | | 10,790,236 |
| Kentucky | 10,381,681 | | 59,544 | | | 4,071 | 210,242 | 97,586 | 10,753,124 |
| Iowa | 7,489,617 | | | | | 73,905 | | 10,800 | 7,574,322 |
| Kansas | 7,322,449 | | | | | | | | 7,322,449 |
| Tennessee | 6,710,401 | | 99,842 | | | | | | 6,810,243 |
| Wyoming | 1,331,406 | | 743,978 | 4,177,606 | | | | | 6,252,990 |
| Maryland | 1,660,297 | | 3,872,331 | | | | | | 5,532,628 |
| Virginia | 4,590,853 | | 85,120 | | 34,922 | | | | 4,710,895 |
| Missouri | 3,942,821 | | | | | 53,256 | | 1,859 | 3,997,936 |
| Washington | 3,051,846 | | 354,228 | 274,458 | | | | | 3,680,532 |
| Oklahoma (Indian Territory) | 3,562,124 | | | | 80,534 | | | | 3,642,658 |
| Arkansas | 1,767,263 | | 11,344 | | 891,831 | | | | 2,670,438 |
| New Mexico | 1,981,768 | 19,870 | | 627,321 | | | | | 2,028,959 |
| Michigan | 2,035,858 | | | | | | | | 2,035,858 |
| Montana | 1,280,744 | | 644,052 | 92,061 | | | | | 2,016,857 |
| Utah | 1,809,570 | | | 138,037 | | | | | 1,947,607 |
| Texas | 899,371 | | 38,766 | 707,732 | | | | 2,200 | 1,648,069 |
| Georgia | 129,535 | | 232,866 | | | | | | 362,401 |
| North Dakota | | | | 347,760 | | | | | 347,760 |
| Oregon | | | | 70,981 | | | | | 70,981 |
| California | | | 4,000 | 9,950 | | | | | 13,950 |
| Alaska | 1,050 | | | 9,089 | | | | | 10,139 |
| Idaho [d] | 4,088 | | | 3,500 | | | | | 7,588 |
| Total | 362,911,826 | 85,666,404 | 15,880,794 | 8,251,249 | 1,007,287 | 1,077,632 | 5,371,557 | 196,675 | 480,363,424 |

[a] Includes 61,000 tons of semisplint coal.
[b] Includes 17,350 tons of semiblock coal.
[c] Includes 2.200 tons of semicannel coal.
[d] Includes Nebraska's and Nevada's production.

## LABOR STATISTICS.

In the following tables are shown the number of men employed and the average time worked in the coal mines of the United States during the last 5 years, by States, and the total number employed in the anthracite and bituminous mines, with the average working time since 1890. The total number of men employed in 1907 was 680,492, against 640,780 in 1906, and 626,035 in 1905. Of the total number of employees in 1907, 513,258, or a little over 75 per cent, were in the bituminous mines, and 167,234, or not quite 25 per cent, were employed in the anthracite mines of Pennsylvania. The average number of days worked by the anthracite miners in 1907 was larger than in any of the last 18 years. There were only two years, 1899 and 1900, in which the number of days made by the bituminous workers equaled the record made in 1907. The anthracite miners in 1907 averaged 220 days, and the bituminous workers 234 days. The average number of days for all the mine workers was 231, against 209 in 1906 and 212 in 1905.

*Statistics of labor employed in coal mines of the United States, 1903–1907, by States.*

| State or Territory. | 1903. |  | 1904. |  | 1905. |  | 1906. |  | 1907. |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Number of days active. | Average number employed. | Number of days active. | Average number employed. | Number of days active. | Average number employed. | Number of days active. | Average number employed. | Number of days active. | Average number employed. |
| Alabama | 228 | 21,438 | 216 | 17,811 | 225 | 19,595 | 237 | 20,555 | 242 | 21,388 |
| Arkansas | 223 | 4,157 | 165 | 4,580 | 177 | 4,192 | 165 | 4,298 | 190 | 5,085 |
| California | [a] 301 | [a] 208 | [a] 282 | [a] 168 | [a] 294 | [a] 144 | [a] 253 | [a] 56 | [a] 187 | [a] 76 |
| Colorado | 245 | 9,229 | 261 | 8,123 | 255 | 11,020 | 268 | 11,368 | 258 | 14,223 |
| Georgia | [b] 296 | [b] 730 | [b] 223 | [b] 906 | [b] 266 | [b] 816 | 279 | 737 | 262 | 808 |
| Idaho | 197 | 32 | [c] 112 | [c] 32 | [c] 107 | [c] 37 | [c] 157 | [c] 25 | [d] 121 | [d] 22 |
| Illinois | 228 | 50,596 | 213 | 54,685 | 201 | 58,053 | 192 | 61,988 | 218 | 65,581 |
| Indiana | 197 | 17,017 | 177 | 19,587 | 151 | 25,323 | 175 | 20,970 | 197 | 21,022 |
| Iowa | 226 | 14,162 | 213 | 15,629 | 209 | 15,113 | 224 | 15,260 | 230 | 15,585 |
| Kansas | 215 | 10,924 | 213 | 12,198 | 212 | 11,926 | 165 | 14,355 | 225 | 12,439 |
| Kentucky | 207 | 14,354 | 197 | 14,235 | 200 | 14,685 | 212 | 15,272 | 210 | 16,971 |
| Maryland | 219 | 5,859 | 226 | 5,671 | 252 | 5,948 | 250 | 6,438 | 263 | 5,880 |
| Michigan | 222 | 2,768 | 183 | 3,549 | 186 | 3,696 | 173 | 3,971 | 234 | 3,982 |
| Missouri | 215 | 9,544 | 206 | 10,137 | 194 | 8,962 | 185 | 9,557 | 214 | 8,448 |
| Montana | 254 | 2,155 | 243 | 2,505 | 243 | 2,181 | 243 | 2,394 | 268 | 2,735 |
| New Mexico | 260 | 1,789 | 228 | 1,849 | 234 | 2,108 | 242 | 2,070 | 269 | 2,970 |
| North Dakota | 198 | 486 | 192 | 554 | 187 | 626 | 209 | 488 | 223 | 562 |
| Ohio | 194 | 41,936 | 175 | 43,634 | 176 | 43,399 | 167 | 45,438 | 199 | 46,833 |
| Oklahoma (Indian Territory) | 247 | 7,704 | 199 | 8,487 | 188 | 7,712 | 166 | 8,251 | 216 | 8,398 |
| Oregon | 258 | 235 | 149 | 334 | 242 | 316 | 224 | 209 | 231 | 184 |
| Pennsylvania bituminous | 235 | 129,265 | 196 | 135,100 | 231 | 143,629 | 231 | 152,099 | 255 | 163,295 |
| Tennessee | 227 | 9,961 | 217 | 10,416 | 222 | 11,928 | 229 | 11,452 | 232 | 12,052 |
| Texas | 242 | 2,380 | 220 | 2,921 | 238 | 3,008 | 227 | 3,048 | 242 | 4,227 |
| Utah | 248 | 1,925 | 294 | 1,374 | 247 | 1,361 | 288 | 1,572 | 258 | 2,203 |
| Virginia | 267 | 5,608 | 238 | 5,165 | 241 | 5,730 | 250 | 5,131 | 241 | 6,670 |
| Washington | 285 | 4,768 | 243 | 5,287 | 227 | 4,765 | 266 | 4,529 | 273 | 5,945 |
| West Virginia | 210 | 41,554 | 197 | 47,235 | 209 | 48,389 | 220 | 50,960 | 230 | 59,029 |
| Wyoming | 252 | 4,993 | 262 | 5,660 | 236 | 5,977 | 281 | 5,934 | 275 | 6,645 |
| Total | 225 | 415,777 | 202 | 437,832 | 211 | 460,629 | 213 | 478,425 | 234 | 513,258 |
| Pennsylvania anthracite | 206 | 150,483 | 200 | 155,861 | 215 | 165,406 | 195 | 162,355 | 220 | 167,234 |
| Grand total | 220 | 566,260 | 202 | 593,693 | 212 | 626,035 | 209 | 640,780 | 231 | 680,492 |

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nevada.
[d] Includes Nebraska and Nevada.

From the statistics presented in the preceding table and the totals of production in the earlier pages of this report, the following table has been prepared, showing the average annual and daily tonnage per man from 1890 to 1907. This table shows that in 1890 the average annual production per man employed in the anthracite mines of Pennsylvania was 369 short tons, while the average daily tonnage per man was 1.85. There was a generally increasing tendency in the productive capacity per man per day in the anthracite fields up to 1899, when the average tonnage per man per day reached 2.5. It then began to fall off until in 1905 the average was 2.18 tons. The records in 1906 and 1907 showed an improvement over that of 1905. In the production of bituminous and lignite coal the average yearly tonnage per man in 1890 was 579 tons and the daily average tonnage per man was 2.56. There has been a tendency toward improvement in the daily tonnage per man during the 18 years included in this table, the best daily record being made in 1906, with 3.36 tons per man per day. In 1907 it was 3.29 tons per man per day. The yearly tonnage in both the anthracite and bituminous mines in 1907 was the largest record, being 512 tons per man in the anthracite region and 769 tons in the bituminous mines.

*Production of coal according to number of persons employed, 1890–1907.*

| Year. | Anthracite. | | | | Bituminous. | | | |
|---|---|---|---|---|---|---|---|---|
| | Men employed. | Days worked. | Average tonnage per man per day. | Average tonnage per man per year. | Men employed. | Days worked. | Average tonnage per man per day. | Average tonnage per man per year. |
| 1890 | 126,000 | 200 | 1.85 | 369 | 192,204 | 226 | 2.56 | 579 |
| 1891 | 126,350 | 203 | 1.98 | 401 | 205,803 | 223 | 2.57 | 573 |
| 1892 | 129,050 | 198 | 2.06 | 407 | 212,893 | 219 | 2.72 | 596 |
| 1893 | 132,944 | 197 | 2.06 | 406 | 230,365 | 204 | 2.73 | 557 |
| 1894 | 131,603 | 190 | 2.08 | 395 | 244,603 | 171 | 2.84 | 486 |
| 1895 | 142,917 | 196 | 2.07 | 406 | 239,962 | 194 | 2.90 | 563 |
| 1896 | 148,991 | 174 | 2.10 | 365 | 244,171 | 192 | 2.94 | 564 |
| 1897 | 149,884 | 150 | 2.34 | 351 | 247,817 | 196 | 3.04 | 596 |
| 1898 | 145,504 | 152 | 2.41 | 367 | 255,717 | 211 | 3.09 | 651 |
| 1899 | 139,608 | 173 | 2.50 | 433 | 271,027 | 234 | 3.05 | 713 |
| 1900 | 144,206 | 166 | 2.40 | 398 | 304,375 | 234 | 2.98 | 697 |
| 1901 | 145,309 | 196 | 2.37 | 464 | 340,235 | 225 | 2.94 | 664 |
| 1902 | 148,141 | 116 | 2.40 | 279 | 370,056 | 230 | 3.06 | 703 |
| 1903 | 150,483 | 206 | 2.41 | 496 | 415,777 | 225 | 3.02 | 680 |
| 1904 | 155,861 | 200 | 2.35 | 469 | 437,832 | 202 | 3.15 | 637 |
| 1905 | 165,406 | 215 | 2.18 | 470 | 460,629 | 211 | 3.24 | 684 |
| 1906 | 162,355 | 195 | 2.25 | 439 | 478,425 | 213 | 3.36 | 717 |
| 1907 | 167,234 | 220 | 2.33 | 512 | 513,258 | 234 | 3.29 | 769 |

In connection with the statistics of labor employed in the bituminous coal mines of the United States, the Geological Survey has during the last 5 or 6 years included in its schedule an inquiry as to the number of hours constituting a day's work. It will be remembered that by the terms of the award of the Anthracite Coal Strike Commission, which terminated on March 31, 1906, the anthracite coal mines of Pennsylvania were placed upon a 9-hour basis for all company men, or those working by the day, with the exception of hoisting engineers, other engineers, and pumpmen, who were allotted 8 hours for a day's work. No number of hours were prescribed for the miners themselves, for the reason that in the anthracite region, as in the bituminous regions, practically all the coal is mined by contract at so much per ton, or per mine car, by yardage, or by other basis of measurement of the coal mined. By an agreement between the operators and the representatives of the miners the award of the Strike Commission has been extended without change for another term of 3 years, or until March 31, 1909.

The statistics for the bituminous mines show that in the States where the miners are more thoroughly organized the 8-hour day prevails. Throughout the central and western fields, for instance, and in Ohio and Michigan, by far the larger number of miners have worked 8 hours a day for several years. In Pennsylvania there were in 1907, 96,667 men employed at 809 bituminous mines who worked 8 hours, against 92,082 men employed at 744 mines in 1906, and 60,297 men employed at 669 mines in 1905. In Ohio 44,733 men out of a total of 46,833 worked 8 hours, and in Illinois 60,268 out of a total of 65,581, in Indiana 18,323 out of a total of 21,022, in Iowa 15,171 out of a total of 15,585, in Missouri 8,079 out of a total of 8,448, in Michigan 3,939 out of a total of 3,982, in Kansas 10,980 out of a total of 12,439, and in Oklahoma 8,079 out of a total of 8,398 worked 8 hours a day. During 1907, through missionary work in the State of Wyoming, the mines of that State were organized, and whereas in 1906, 5,500 men out a total of 5,934 worked 10 hours, in 1907, 6,382 men out of a total of 6,645 worked 8 hours. The 9 or 10 hour day prevails more than the 8 hour day in Alabama, Colorado, Kentucky, Maryland, New Mexico, Tennessee, Virginia, and West Virginia.

There are so many influences affecting the production of coal in the different States that it has not been possible to draw any reliable conclusions in regard to the effect of the length of the day's work upon the intensity of labor, though some averages are presented in the following pages which may or may not indicate the tendency in this particular. Principal among the influences is the rapidly increasing use of mining machinery among the bituminous mines and other mechanical equipment which has for its object the cheapening of production and the increase of output per man. The most striking facts presented have been the decreased production per man per day in the anthracite region, where mining machines are not employed (exceptions being noted in 1906 and 1907), and the increased output per man per day in the bituminous districts, which is due in most part to undercutting machinery. It is interesting to note that in Wyoming, where the length of day was reduced from 10 hours in 1906 to 8 hours in 1907, the average production per man decreased from 3.68 to 3.42 per day per man, and from 1,033 to 941 for the year.

In the following tables the figures are given for the more important States, the ones omitted having too small a production to be of any interest in this report:

*Number of hours to the working day in 1906 and 1907, by States and Territories.*

## 1906.

| State or Territory. | 8 hours. |  | 9 hours. |  | 10 hours. |  | All others.[a] |
|---|---|---|---|---|---|---|---|
|  | Mines. | Men. | Mines. | Men. | Mines. | Men. | Men. |
| Alabama | 27 | 1,096 | 37 | 7,808 | 91 | 11,258 | 393 |
| Arkansas | 55 | 4,282 | ..... | ..... | ..... | ..... | 16 |
| Colorado | 67 | [b] 5,259 | 9 | 655 | 48 | 5,222 | 232 |
| Illinois | 482 | [b] 60,081 | 9 | 610 | 1 | 30 | 1,267 |
| Indiana | 230 | 19,842 | 2 | 100 | ..... | ..... | 1,028 |
| Indian Territory | 70 | 7,824 | 3 | 167 | 4 | 81 | 179 |
| Iowa | 195 | 14,869 | 2 | 20 | 1 | 8 | 363 |
| Kansas | 141 | 12,606 | 7 | 94 | 3 | 399 | 1,256 |
| Kentucky | 60 | 4,171 | 65 | 3,972 | 79 | 5,941 | 1,188 |
| Maryland | ..... | ..... | 1 | 50 | 45 | 6,358 | 30 |
| Michigan | 27 | 3,941 | ..... | ..... | ..... | ..... | 30 |
| Missouri | 134 | 8,645 | 6 | 58 | 6 | 80 | 774 |
| Montana | 28 | [b] 2,203 | 1 | 85 | ..... | ..... | 106 |
| New Mexico | 8 | 78 | 2 | 24 | 16 | 1,856 | 112 |
| North Dakota | 6 | 47 | 4 | 38 | 20 | 323 | 80 |
| Ohio | 461 | 44,003 | 8 | 174 | 3 | 76 | 1,185 |
| Oregon | 1 | 4 | ..... | ..... | 2 | 195 | 10 |
| Pennsylvania | 744 | [b] 92,082 | 233 | 25,695 | 190 | 30,895 | 3,427 |
| Tennessee | 4 | 246 | 79 | 6,938 | 30 | 4,034 | 234 |
| Texas | 10 | 1,817 | ..... | ..... | 8 | 703 | 528 |
| Utah | 12 | 1,554 | 1 | 2 | 1 | 3 | 13 |
| Virginia | 6 | 105 | 5 | 727 | 31 | 4,294 | 5 |
| Washington | 29 | [b] 4,179 | 4 | 106 | 2 | 13 | 231 |
| West Virginia | 43 | [b] 2,510 | 190 | 15,208 | 308 | 31,531 | 1,711 |
| Wyoming | 2 | 8 | 2 | 25 | 29 | 5,500 | 401 |
| Total | 2,842 | 291,452 | 670 | 62,556 | 918 | 108,800 | 14,799 |

## 1907.

| State or Territory. | 8 hours. |  | 9 hours. |  | 10 hours. |  | All others.[a] |
|---|---|---|---|---|---|---|---|
|  | Mines. | Men. | Mines. | Men. | Mines. | Men. | Men. |
| Alabama | 31 | 1,994 | 34 | 2,339 | 84 | 13,942 | 3,113 |
| Arkansas | 67 | 4,970 | ..... | ..... | ..... | ..... | 115 |
| Colorado | 60 | 3,420 | 8 | 312 | 54 | 7,439 | 3,052 |
| Illinois | 457 | 60,268 | 8 | 675 | 1 | 4 | 4,634 |
| Indiana | 208 | 18,323 | ..... | ..... | ..... | ..... | 2,699 |
| Iowa | 175 | 15,171 | 1 | 10 | ..... | ..... | 404 |
| Kansas | 134 | 10,980 | 10 | 156 | 1 | 10 | 1,293 |
| Kentucky | 60 | 4,610 | 71 | 4,508 | 97 | 6,842 | 1,011 |
| Maryland | ..... | ..... | 5 | 84 | 57 | 5,693 | 103 |
| Michigan | 27 | 3,939 | ..... | ..... | ..... | ..... | 43 |
| Missouri | 149 | 8,079 | 6 | 54 | ..... | ..... | 315 |
| Montana | 29 | 2,732 | 1 | 3 | ..... | ..... | ..... |
| New Mexico | 8 | 79 | 4 | 287 | 14 | 2,584 | 20 |
| North Dakota | 11 | 89 | 6 | 119 | 17 | 304 | 50 |
| Ohio | 490 | 44,733 | 4 | 53 | 2 | 31 | 2,016 |
| Oklahoma (Indian Territory) | 83 | 8,079 | ..... | ..... | 6 | 194 | 125 |
| Oregon | 3 | 184 | ..... | ..... | ..... | ..... | ..... |
| Pennsylvania | 809 | 96,667 | 260 | 24,883 | 198 | 35,355 | 6,390 |
| Tennessee | 13 | 1,561 | 75 | 6,968 | 27 | 3,379 | 144 |
| Texas | 5 | 1,453 | 1 | 60 | 16 | 2,202 | 512 |
| Utah | 16 | 2,046 | ..... | ..... | ..... | ..... | 157 |
| Virginia | ..... | ..... | 7 | 849 | 42 | 5,791 | 30 |
| Washington | 41 | 5,594 | 1 | 5 | ..... | ..... | 346 |
| West Virginia | 35 | 1,879 | 156 | 13,386 | 322 | 32,005 | 11,759 |
| Wyoming | 37 | 6,382 | 6 | 197 | ..... | ..... | 66 |
| Total | 2,948 | 303,232 | 664 | 54,948 | 938 | 115,775 | 38,397 |

[a] Including mines not reporting hours per day.

[b] Including day men who work 10 hours.

In the following table is presented a statement of the average production per man per day and per year, compared with the average number of days worked by each man and the hours per day reported by the majority of mines in the important coal-producing States during the last 3 years. It is not claimed that this statement indicates accurately the effect the number of hours per day exerts upon the intensity of labor, because the conditions vary materially in the different States. In Utah, for instance, where 8 hours is the prevailing length of the labor day, the average tonnage per man is high, although there was a decided falling off in 1907 as compared with any of the 3 preceding years. In the production of Pennsylvania bituminous coal, in Illinois and in Ohio (in all of which the 8-hour day prevails), the average production per day per man ranged from 3.45 to 3.60. On the other hand, in Maryland and West Virginia, where the mines were operated on a 10-hour basis, the production was, respectively, 3.58 and 3.54 tons per day per man. In Wyoming, as previously stated, the length of the working day was reduced from 10 hours in 1906 to 8 hours in 1907, and the average production for each employee fell off from 3 68 to 3.42 tons per day.

*Average production per man compared with hours worked per day, and average number of days per year in 1905, 1906, and 1907.*

| State or Territory. | 1905. | | | | 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of hours per day. | Days worked. | Average tonnage. | | Number of hours per day. | Days worked. | Average tonnage. | | Number of hours per day. | Days worked. | Average tonnage. | |
| | | | Per year. | Per day. | | | Per year. | Per day. | | | Per year. | Per day. |
| Alabama | 9 and 10 | 225 | 605.6 | 2.69 | 9 and 10 | 237 | 637.7 | 2.69 | 9 and 10 | 242 | 666.3 | 2.75 |
| Arkansas | 8 | 177 | 461.5 | 2.60 | 8 | 165 | 433.8 | 2.63 | 8 | 190 | 525.2 | 2.76 |
| Colorado | 10 | 255 | 800.9 | 3.14 | 8 and 10 | 268 | 889.4 | 3.32 | 8 and 10 | 258 | 758.6 | 2.94 |
| Illinois | 8 | 201 | 662.1 | 3.29 | 8 | 192 | 669.2 | 3.49 | 8 | 218 | 782.5 | 3.59 |
| Indiana | 8 | 151 | 469.7 | 3.11 | 8 | 175 | 576.7 | 3.30 | 8 | 197 | 665.3 | 3.38 |
| Iowa | 8 | 209 | 449.9 | 2.15 | 8 | 224 | 476.2 | 2.13 | 8 | 230 | 486.0 | 2.11 |
| Kansas | 8 | 212 | 538.7 | 2.54 | 8 | 165 | 419.7 | 2.54 | 8 | 225 | 588.7 | 2.62 |
| Kentucky | 9 and 10 | 200 | 574.2 | 2.87 | 9 and 10 | 212 | 632.1 | 2.98 | 8, 9, and 10 | 210 | 633.6 | 3.02 |
| Maryland | 10 | 252 | 858.9 | 3.41 | 10 | 250 | 844.3 | 3.38 | 10 | 263 | 940.9 | 3.58 |
| Michigan | 8 | 186 | 398.6 | 2.14 | 8 | 173 | 339.0 | 1.96 | 8 | 234 | 511.3 | 2.19 |
| Missouri | 8 | 194 | 444.5 | 2.29 | 8 | 185 | 393.2 | 2.13 | 8 | 214 | 473.2 | 2.21 |
| Montana | 8 | 243 | 753.7 | 3.10 | 8 | 243 | 764.4 | 3.15 | 8 | 268 | 737.4 | 2.75 |
| New Mexico | 10 | 234 | 782.7 | 3.34 | 10 | 242 | 949.1 | 3.92 | 10 | 269 | 885.2 | 3.29 |
| Ohio | 8 | 176 | 588.9 | 3.35 | 8 | 167 | 610.3 | 3.65 | 8 | 199 | 686.3 | 3.45 |
| Oklahoma (Indian Territory) | 8 | 188 | 379.2 | 2.02 | 8 | 166 | 346.6 | 2.09 | 8 | 216 | 433.8 | 2.01 |
| Pennsylvania: | | | | | | | | | | | | |
| Anthracite | 9 | 215 | 469.5 | 2.18 | 9 | 195 | 439.1 | 2.25 | 9 | 220 | 511.9 | 2.33 |
| Bituminous | 8 | 231 | 824.4 | 3.57 | 8 | 231 | 850.1 | 3.68 | [a] 8 | 255 | 919.5 | 3.61 |
| Tennessee | 9 and 10 | 221 | 483.5 | 2.29 | 9 and 10 | 229 | 546.6 | 2.39 | 9 and 10 | 232 | 565.1 | 2.44 |
| Utah | 8 | 247 | 979.0 | 3.96 | 8 | 288 | 1,127.6 | 3.92 | 8 | 258 | 884.1 | 3.43 |
| Virginia | 10 | 241 | 746.1 | 3.10 | 10 | 250 | 829.2 | 3.32 | 10 | 241 | 706.3 | 2.93 |
| Washington | 8 | 227 | 601.2 | 2.65 | 8 | 266 | 723.4 | 2.72 | 8 | 273 | 619.1 | 2.27 |
| West Virginia | 9 and 10 | 209 | 781.0 | 3.74 | 9 and 10 | 220 | 849.5 | 3.86 | 9 and 10 | 230 | 814.7 | 3.54 |
| Wyoming | 10 | 236 | 937.3 | 3.97 | 10 | 281 | 1,033.7 | 3.68 | 8 | 275 | 941.0 | 3.42 |

[a] Represents 60 per cent of employees; the other 40 per cent about evenly divided between 9 and 10 hours.

## LABOR TROUBLES.

So far as the controversies between employees and employer were concerned, the year 1907 was the banner year in recent coal-mining history. There was only one year (1901) in the last 9 in which there were fewer men on strike, and in that year the time lost was more than that of 1907. Compared with 1906, the year 1907 stood out with particular prominence, the former year having witnessed one of the most peculiar controversies in the history of the industry. There was more time lost in 1906 than in any year for which the statistics of this character have been prepared, with the single exception of 1902, a year made famous by the great strike in the anthracite region of Pennsylvania, and by sympathetic or coordinate strikes in the organized bituminous States, and yet there were not, as such, any "strikes" of moment in 1906. The idleness was due to a peaceful suspension of mining operations on April 1, pending an adjustment of the wage scale. There was no strike order issued, the men being simply requested to cease work until the wage questions were settled. Both miners and operators had been prepared for this for months in advance, and there was no serious interruption to other lines of business because of the scarcity of coal, although prices were advanced to a considerable extent. When in June mining was resumed in the bituminous regions it was under an agreement signed for 2 years, or until March 31, 1909. In the anthracite region of Pennsylvania miners formulated demands for certain changes in their conditions of employment, but as the region had been peaceful and prosperous for 3 years under the awards of the strike commission, the operators declined to entertain the demands and simply proposed a renewal of those awards for another term of 3 years. After an idleness of about 6 weeks this proposition was finally accepted without amendment by the miners.

The most prolonged strikes in 1907 were in two States in which the miners' organization was not strongly intrenched, namely, Alabama and Kentucky. In Alabama there were 80 men idle for an average of 45 days, and in Kentucky 1,325 men were idle for an average of 41 days. The total number of men idle in 1907 was 32,540, and the average time lost was 14 days per man.

The statistics of labor troubles in the coal mines of the United States in 1906 and 1907, by States, are presented in the following tables:

*Statistics of labor strikes in the coal mines of the United States in 1906 and 1907.*

| State or Territory. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Number of men on strike. | Total days lost. | Average number of days lost per man. | Number of men on strike. | Total days lost. | Average number of days lost per man. |
| Alabama | 549 | 6,576 | 12 | 80 | 3,600 | 45 |
| Arkansas | 3,828 | 291,095 | 76 | 1,185 | 35,835 | 30 |
| Colorado | ........ | ........ | ........ | 215 | 6,378 | 30 |
| Illinois | 49,792 | 2,900,525 | 58 | 5,255 | 35,191 | 7 |
| Indiana | 15,875 | 995,217 | 63 | 3,176 | 42,842 | 13 |
| Iowa | 7,969 | 204,860 | 28 | 1,621 | 8,265 | 5 |
| Kansas | 11,827 | 709,422 | 59 | 923 | 16,957 | 18 |
| Kentucky | 1,242 | 44,812 | 36 | 1,325 | 53,916 | 41 |
| Maryland | 30 | 300 | 10 | 510 | 13,770 | 27 |
| Michigan | 3,340 | 294,630 | 88 | 265 | 1,325 | 5 |
| Missouri | 6,212 | 483,790 | 78 | 777 | 8,222 | 11 |
| Montana | 230 | 7,030 | 31 | 30 | 600 | 20 |
| North Dakota | 37 | 92 | 2 | 82 | 736 | 9 |
| Ohio | 37,636 | 2,687,288 | 71 | 6,367 | 110,324 | 17 |
| Oklahoma (Indian Territory) | 7,372 | 535,504 | 72 | 669 | 17,092 | 26 |
| Oregon | ........ | ........ | ........ | 25 | 225 | 9 |
| Pennsylvania | 59,593 | 3,941,835 | 66 | 6,447 | 59,834 | 9 |
| Tennessee | 180 | 1,185 | 7 | 284 | 4,725 | 17 |
| Texas | 1,260 | 9,245 | 7 | 270 | 1,610 | 6 |
| Utah | ........ | ........ | ........ | 148 | 592 | 4 |
| Washington | ........ | ........ | ........ | 484 | 8,544 | 18 |
| West Virginia | 4,101 | 123,724 | 30 | 617 | 9,749 | 16 |
| Wyoming | 231 | 5,775 | 25 | 1,785 | 22,000 | 12 |
| Total bituminous | 211,304 | 13,242,905 | 63 | 32,540 | 462,392 | 14 |
| Pennsylvania anthracite | 161,039 | 5,958,443 | 37 | ........ | ........ | ........ |
| Grand total | 372,343 | 19,201,348 | 51.5 | 32,540 | 462,392 | 14 |

A summary of the statistics of strikes in the coal mines of the United States since 1899 is given in the following table:

*Summary of labor strikes in the coal mines of the United States, 1899–1907.*

| Year. | Number of men on strike. | Total working days lost. | Average number of days lost per man. |
|---|---|---|---|
| 1899 | 45,981 | 2,124,154 | 46 |
| 1900 | 131,973 | 4,878,102 | 37 |
| 1901 [a] | 20,593 | 733,802 | 35 |
| 1902 | 200,452 | 16,672,217 | 83 |
| 1903 [a] | 47,481 | 1,341,031 | 28 |
| 1904 | 77,661 | 3,382,830 | 44 |
| 1905 | 37,542 | 796,735 | 21 |
| 1906 | 372,343 | 19,201,348 | 51.5 |
| 1907 | 32,540 | 462,392 | 14 |

[a] Bituminous mines only.

## COAL MINED BY MACHINES.

In 1907, as for several years past, one of the notable features presented by the statistics of bituminous coal production was the growth exhibited in the use of machines and in the quantity of coal won with them. The number of mining machines in use increased from 10,212 in 1906 to 11,144 in 1907, while the machine-mined product increased from 118,847,527 short tons to 138,547,823 short tons in 1907, an increase of 19,700,296 tons, or 16.58 per cent. The percentage of the machine-mined product to the total production of the States in which mining machines were in use increased from 35.10 to 35.71, and the increase in machine-mined coal was equal to 38 per cent of the total increase in the production of bituminous coal in 1907 over 1906. The statistics for the last 3 years also show a considerable increase in the production of coal for each machine in use, the average production for each machine having increased from 10,258 short tons in 1904 to 11,258 short tons in 1905, 11,638 short tons in 1906, and to 12,381 short tons in 1907. Of the 11,144 machines in use in 1907, 6,227 were of the pick or puncher type, 4,652 were chain-breast machines, and 265 were long-wall. In the number of machines in use and in the quantity of machine-mined tonnage, as in the total production of coal, Pennsylvania stands well in the lead, with 44.3 per cent of the number of machines and 44 per cent of the machine-mined product in 1907. The quantity of coal mined by machines in Pennsylvania in 1907 was 60,771,157 short tons, against 54,146,314 tons in 1906. Ohio's machine-mined production amounted to 24,843,616 short tons in 1907, against 20,004,416 tons in 1906. West Virginia ranks third in the machine-mined tonnage, with a total of 17,627,925 short tons in 1907 and 15,565,113 tons in 1906. The production of machine-mined coal in Illinois in 1907 was 15,134,401 short tons, against 11,585,419 tons in 1906. Ohio, the fourth in rank among the coal-producing States, stands first in the percentage of machine-mined coal to the total product, 77.29 per cent of Ohio's product in 1907 having been machine-mined. Kentucky ranks second in the percentage of machine-mined coal in 1907, with 51.19 per cent of the total.

The statistics in regard to the coal mined by machines during the last five years are shown in the following table, together with the number of machines used in each State, the number of tons mined by machines, the total production of the States in which machines were used, and the percentage of the machine-mined product to the total of those States:

*Bituminous coal mined by machines in the United States, 1903–1907, by States and Territories.*

| State or Territory. | Number of machines in use. | | | | | Number of tons mined by machines. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1903. | 1904. | 1905. | 1906. | 1907. | 1903. | 1904. | 1905. | 1906. | 1907. |
| Alabama | 98 | 141 | 213 | 238 | 197 | 577,317 | 741,170 | 1,584,942 | 1,641,476 | 1,762,948 |
| Arkansas | | | | | | | | | | |
| Colorado | 157 | 125 | 121 | 141 | 175 | 1,270,221 | 945,965 | 1,247,687 | 1,337,006 | 1,689,517 |
| Georgia | | | 6 | | | | | 11,684 | | |
| Illinois | 553 | 643 | 882 | 1,048 | 1,080 | 7,381,027 | 7,110,902 | 8,697,547 | 11,585,419 | 15,134,401 |
| Indiana | 329 | 403 | 506 | 471 | 513 | 3,334,961 | 3,613,532 | 4,207,246 | 4,251,740 | 5,310,607 |
| Iowa | 10 | 39 | 32 | 34 | 33 | 55,085 | 175,742 | 186,224 | 193,666 | 108,022 |
| Kansas | 5 | 5 | 10 | 6 | 6 | 9,876 | 10,600 | 19,101 | 30,450 | 35,317 |
| Kentucky | 308 | 453 | 527 | 600 | 708 | 2,843,805 | 3,595,513 | 4,409,054 | 5,175,950 | 5,504,262 |
| Maryland | 36 | 38 | 42 | 45 | 43 | 401,144 | 484,373 | 468,822 | 427,450 | 479,110 |
| Michigan | 46 | 85 | 106 | 110 | 103 | 180,943 | 310,007 | 432,266 | 417,073 | 606,718 |
| Missouri | 33 | 31 | 30 | 48 | 62 | 311,602 | 376,505 | 375,194 | 419,288 | 486,882 |
| Montana | 63 | 57 | 58 | 76 | 86 | 693,504 | 482,924 | 752,665 | 974,306 | 984,368 |
| New Mexico | 12 | 12 | | | 3 | 105,000 | 100,000 | | | 11,615 |
| North Dakota | 9 | 9 | 9 | 11 | 12 | 115,222 | 125,097 | 97,789 | 97,035 | 136,700 |
| Ohio | 724 | 865 | 1,041 | 1,255 | 1,328 | 14,007,326 | 13,983,647 | 16,888,417 | 20,004,416 | 24,843,616 |
| Oklahoma (Indian Territory) | 36 | 18 | 29 | 29 | 11 | 73,304 | 42,594 | 40,203 | 33,357 | 24,331 |
| Pennsylvania | 3,310 | 3,645 | 4,254 | 4,515 | 4,940 | 37,146,253 | 35,174,613 | 49,335,660 | 54,146,314 | 60,771,157 |
| Tennessee | 51 | 85 | 89 | 128 | 137 | 304,602 | 440,618 | 479,471 | 747,500 | 874,925 |
| Texas | 8 | 9 | 8 | 12 | 13 | 29,000 | 33,154 | 22,400 | 22,682 | 36,100 |
| Utah | 13 | 9 | | 2 | 5 | 75,000 | 34,054 | | 1,000 | 1,800 |
| Virginia | 10 | 18 | 35 | 37 | 77 | 82,040 | 245,536 | 399,029 | 424,343 | 788,793 |
| Washington | | | | 1 | | | | | 12,521 | |
| West Virginia | 788 | 901 | 1,105 | 1,322 | 1,533 | 8,193,840 | 9,526,749 | 12,504,301 | 15,565,113 | 17,627,925 |
| Wyoming | 59 | 72 | 81 | 83 | 79 | 783,822 | 1,053,702 | 1,236,750 | 1,339,422 | 1,328,709 |
| Total | 6,658 | 7,663 | 9,184 | 10,212 | 11,144 | 77,974,894 | 78,606,997 | 103,396,452 | 118,847,527 | 138,547,823 |

*Bituminous coal mined by machines in the United States, 1903–1907, by States and Territories*—Continued.

| State or Territory. | Total tonnage of States using mining machinery. | | | | | Percentage of total product mined by machines. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1903. | 1904. | 1905. | 1906. | 1907. | 1903. | 1904. | 1905. | 1906. | 1907. |
| Alabama | 11,654,324 | 11,262,046 | 11,866,069 | 13,107,963 | 14,250,454 | 4.95 | 6.58 | 13.36 | 12.52 | 12.37 |
| Arkansas | | | | | | | | | | |
| Colorado | 7,423,602 | 6,658,355 | 8,826,429 | 10,111,218 | 10,790,236 | 17.11 | 14.21 | 14.14 | 13.22 | 15.66 |
| Georgia | | | 351,991 | | | | | 3.32 | | |
| Illinois | 36,957,104 | 36,475,060 | 38,434,363 | 41,480,104 | 51,317,146 | 19.97 | 19.50 | 22.63 | 27.93 | 29.49 |
| Indiana | 10,794,692 | 10,842,189 | 11,895,252 | 12,092,560 | 13,985,713 | 30.90 | 33.33 | 35.37 | 35.16 | 37.97 |
| Iowa | 6,419,811 | 6,519,933 | 6,798,609 | 7,266,224 | 7,574,322 | .86 | 2.70 | 2.74 | 2.67 | 1.43 |
| Kansas | 5,839,976 | 6,333,307 | 6,423,979 | 6,024,775 | 7,322,449 | .17 | .17 | .30 | .51 | .48 |
| Kentucky | 7,538,032 | 7,576,482 | 8,432,523 | 9,653,647 | 10,753,124 | 37.73 | 47.46 | 51.44 | 53.62 | 51.19 |
| Maryland | 4,846,165 | 4,813,622 | 5,108,539 | 5,435,453 | 5,532,628 | 8.28 | 10.06 | 9.18 | 7.86 | 8.66 |
| Michigan | 1,367,619 | 1,342,840 | 1,473,211 | 1,346,338 | 2,035,858 | 13.23 | 23.09 | 29.34 | 30.98 | 29.80 |
| Missouri | 4,238,586 | 4,168,308 | 3,983,378 | 3,758,008 | 3,997,936 | 7.35 | 9.03 | 9.42 | 11.16 | 12.46 |
| Montana | 1,488,810 | 1,358,919 | 1,643,832 | 1,829,921 | 2,016,857 | 46.58 | 35.54 | 45.79 | 53.24 | 48.81 |
| New Mexico | 1,541,781 | 1,452,325 | | | 2,628,959 | 9.40 | 6.89 | | | .44 |
| North Dakota | 278,645 | 271,928 | 317,542 | 305,689 | 347,760 | 41.35 | 46.00 | 30.80 | 31.74 | 39.31 |
| Ohio | 24,838,103 | 24,400,220 | 25,552,950 | 27,731,640 | 32,142,419 | 56.39 | 57.31 | 66.10 | 72.14 | 77.29 |
| Oklahoma (Indian Territory) | 3,517,388 | 3,046,539 | 2,924,427 | 2,860,200 | 3,642,658 | 2.08 | 1.40 | 1.37 | 1.17 | .67 |
| Pennsylvania | 103,117,178 | 97,938,287 | 118,413,637 | 129,293,206 | 150,143,177 | 36.02 | 35.92 | 41.66 | 41.88 | 40.48 |
| Tennessee | 4,798,004 | 4,782,211 | 5,766,690 | 6,259,275 | 6,810,243 | 6.35 | 9.21 | 8.31 | 11.94 | 12.85 |
| Texas | 926,759 | 1,195,944 | 1,200,684 | 1,312,873 | 1,648,069 | 3.13 | 2.77 | 1.86 | 1.73 | 2.19 |
| Utah | 1,681,409 | 1,493,027 | | 1,772,551 | 1,947,607 | 4.46 | 2.28 | | .06 | .09 |
| Virginia | 3,451,307 | 3,410,914 | 4,275,271 | 4,254,879 | 4,710,895 | 2.38 | 7.20 | 9.33 | 9.97 | 16.74 |
| Washington | | | | 3,276,184 | | | | | .38 | |
| West Virginia | 29,337,241 | 32,406,752 | 37,791,580 | 43,290,350 | 48,091,583 | 27.93 | 29.40 | 33.09 | 35.96 | 36.65 |
| Wyoming | 4,635,293 | 5,178,556 | 5,602,021 | 6,133,994 | 6,252,990 | 16.91 | 20.35 | 22.08 | 21.84 | 21.25 |
| Total | 276,691,829 | 272,927,764 | 307,082,977 | 338,597,052 | 387,943,083 | [a] 28.18 | [a] 28.80 | [a] 33.67 | [a] 35.10 | [a] 35.71 |

[a] Average.

In the following table are shown the number and kinds of machines in use in each State in 1906 and 1907:

*Number and kinds of machines in use in 1906 and 1907, by States and Territories.*

| State or Territory. | 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|---|
| | Pick. | Chain breast. | Long wall. | Total. | Pick. | Chain breast. | Long wall. | Total. |
| Alabama | 177 | 61 | ........ | 238 | 152 | 42 | 3 | 197 |
| Colorado | 80 | 51 | 10 | 141 | 103 | 58 | 14 | 175 |
| Illinois | 874 | 171 | 3 | 1,048 | 836 | 243 | 1 | 1,080 |
| Indiana | 124 | 329 | 18 | 471 | 147 | 308 | 58 | 513 |
| Iowa | 11 | 14 | 9 | 34 | 16 | 9 | 8 | 33 |
| Kansas | 6 | ........ | ........ | 6 | 3 | 3 | ........ | 6 |
| Kentucky | 419 | 175 | 6 | 600 | 475 | 205 | 28 | 708 |
| Maryland | 45 | ........ | ........ | 45 | 43 | ........ | ........ | 43 |
| Michigan | 88 | 22 | ........ | 110 | 60 | 42 | 1 | 103 |
| Missouri | 4 | ........ | 44 | 48 | 4 | 4 | 54 | 62 |
| Montana | 70 | 6 | ........ | 76 | 76 | 10 | ........ | 86 |
| New Mexico | ........ | ........ | ........ | ........ | 3 | ........ | ........ | 3 |
| North Dakota | ........ | 11 | ........ | 11 | ........ | 12 | ........ | 12 |
| Ohio | 141 | 1,081 | 33 | 1,255 | 109 | 1,213 | 6 | 1,328 |
| Oklahoma (Indian Territory) | 18 | 11 | ........ | 29 | 7 | 3 | 1 | 11 |
| Pennsylvania | 3,103 | 1,393 | 19 | 4,515 | 3,372 | 1,547 | 21 | 4,940 |
| Tennessee | 112 | 14 | 2 | 128 | 120 | 14 | 3 | 137 |
| Texas | 9 | ........ | 3 | 12 | 10 | ........ | 3 | 13 |
| Utah | 1 | ........ | 1 | 2 | 3 | 2 | ........ | 5 |
| Virginia | 10 | 27 | ........ | 37 | 26 | 51 | ........ | 77 |
| Washington | ........ | ........ | 1 | 1 | ........ | ........ | ........ | ........ |
| West Virginia | 571 | 744 | 7 | 1,322 | 617 | 853 | 63 | 1,533 |
| Wyoming | 48 | 34 | 1 | 83 | 45 | 33 | 1 | 79 |
| Total | 5,911 | 4,144 | 157 | [a]10,212 | 6,227 | 4,652 | 265 | [b]11,144 |

[a] Includes 11 pick and 26 chain shearing machines.
[b] Includes 20 pick and 268 chain shearing machines.

The statistics relating to the use of mining machines were first collected by the Survey for the year 1896. The inquiries at this time asked also for reports on the number of machines in use and the quantity of coal won by them in 1891, five years previous. From the returns to the Survey since 1896, the results of which in detail have been published in the preceding volumes of Mineral Resources, the following table has been prepared showing the development in the mechanical mining of bituminous coal since 1891:

*Production of coal by machines in the United States since 1891, in short tons.*

| Year. | Number of machines in use. | Total tonnage won by machines. | Average production for each machine. |
|---|---|---|---|
| 1891 | 545 | 6,211,732 | 11,398 |
| 1896 | 1,446 | 16,424,932 | 11,373 |
| 1897 | 1,956 | 22,649,220 | 11,579 |
| 1898 | 2,622 | 32,413,144 | 12,362 |
| 1899 | 3,125 | 43,963,933 | 14,068 |
| 1900 | 3,907 | 52,784,523 | 13,510 |
| 1901 | 4,341 | 57,843,335 | 13,325 |
| 1902 | 5,418 | 69,611,582 | 12,848 |
| 1903 | 6,658 | 77,974,894 | 11,712 |
| 1904 | 7,663 | 78,606,997 | 10,258 |
| 1905 | 9,184 | 103,396,452 | 11,258 |
| 1906 | 10,212 | 118,847,527 | 11,638 |
| 1907 | 11,144 | 137,973,701 | 12,381 |

It would seem that while there is an increase in the use of mining machinery there should be an increase both for the year and for the day in the average production per employee, and in previous years this has to a considerable extent prevailed. The records for 1907, however, show somewhat of a contrary effect. In Ohio's machine-mined production, the percentage of which increased from 72.14 in 1906 to 77.29 in 1907, there was a decrease from 3.65 to 3.45 in the average tonnage per day per man. The percentage of West Virginia's machine-mined production to the total for the States increased from 35.96 to 36.65, while the average daily production per man fell off from 3.86 to 3.54. In the production of bituminous coal in Pennsylvania there was a decrease in the percentage of machine-mined coal and also in the daily production per man. Illinois, on the other hand, showed an increase of from 27.93 to 29.49 in the machine-mined tonnage, and an increase from 3.49 to 3.59 in the daily production per man.

*Average production per man compared with production by machines in 1906 and 1907, by States and Territories, in short tons.*

| State or Territory. | Average tonnage. |  |  |  | Production by machines. |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Per year. |  | Per day. |  | Total tonnage by machines. |  | Per cent of machine coal to State total. |  |
|  | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. |
| Alabama | 637.7 | 666.3 | 2.69 | 2.75 | 1,641,476 | 1,762,948 | 12.52 | 12.37 |
| Arkansas | 433.8 | 525.2 | 2.63 | 2.76 | ........ | ........ | ........ | ........ |
| Colorado | 889.4 | 758.6 | 3.32 | 2.94 | 1,337,006 | 1,689,517 | 13.22 | 15.66 |
| Illinois | 669.2 | 782.5 | 3.49 | 3.59 | 11,585,419 | 15,134,401 | 27.93 | 29.49 |
| Indiana | 576.7 | 665.3 | 3.30 | 3.38 | 4,251,740 | 5,310,607 | 35.16 | 37.97 |
| Iowa | 476.2 | 486.0 | 2.13 | 2.11 | 193,666 | 108,022 | 2.67 | 1.43 |
| Kansas | 419.7 | 588.7 | 2.54 | 2.62 | 30,450 | 35,317 | .51 | .48 |
| Kentucky | 632.1 | 633.6 | 2.98 | 3.02 | 5,175,950 | 5,504,262 | 53.62 | 51.19 |
| Maryland | 844.3 | 940.9 | 3.38 | 3.58 | 427,450 | 479,110 | 7.86 | 8.66 |
| Michigan | 339.0 | 511.3 | 1.96 | 2.19 | 417,073 | 606,718 | 30.98 | 29.80 |
| Missouri | 393.2 | 473.2 | 2.13 | 2.21 | 419,288 | 486,882 | 11.16 | 12.18 |
| Montana | 764.4 | 737.4 | 3.15 | 2.75 | 974,306 | 984,368 | 53.24 | 48.81 |
| New Mexico | 949.1 | 885.2 | 3.92 | 3.29 | ........ | 11,615 | ........ | .44 |
| North Dakota | 626.4 | 618.8 | 3.00 | 2.78 | 97,035 | 136,700 | 31.74 | 39.31 |
| Ohio | 610.3 | 686.3 | 3.65 | 3.45 | 20,004,416 | 24,843,616 | 72.14 | 77.29 |
| Oklahoma (Indian Territory) | 346.6 | 433.8 | 2.09 | 2.01 | 33,357 | 24,331 | 1.17 | .67 |
| Pennsylvania: |  |  |  |  |  |  |  |  |
| Anthracite | 439.1 | 511.9 | 2.25 | 2.33 | ........ | ........ | ........ | ........ |
| Bituminous | 850.1 | 919.5 | 3.68 | 3.61 | 54,146,314 | 60,771,157 | 41.88 | 40.48 |
| Tennessee | 546.6 | 565.1 | 2.39 | 2.44 | 747,500 | 874,925 | 11.94 | 12.85 |
| Texas | 430.7 | 389.9 | 1.90 | 1.61 | 22,682 | 36,100 | 1.73 | 2.19 |
| Utah | 1,127.6 | 884.1 | 3.92 | 3.43 | 1,000 | 1,800 | .06 | .09 |
| Virginia | 829.2 | 706.3 | 3.32 | 2.93 | 424,343 | 788,793 | 9.97 | 16.74 |
| Washington | 723.4 | 619.1 | 2.72 | 2.27 | 12,521 | ........ | .38 | ........ |
| West Virginia | 849.5 | 814.7 | 3.86 | 3.54 | 15,565,113 | 17,627,925 | 35.96 | 36.65 |
| Wyoming | 1,033.7 | 941.0 | 3.68 | 3.42 | 1,330,422 | 1,328,709 | 21.84 | 21.25 |

## COAL-MINING ACCIDENTS.

Any statement regarding the coal-mining accidents which attempts to cover the entire United States must necessarily be somewhat incomplete. Statistics of this character are not collected by the Geological Survey, and the information relating thereto contained in this report has been obtained through the courtesy of State or Territory mine inspectors or other officials by whom data concerning accidents and their causes and effects are compiled. In a number of States where coal is produced there are no officials charged with these duties, and in one or two instances no replies have been received to the inquiries from this office.

The record of accidents in 1907 is the worst in recent years, particularly in the number of men killed by explosions of gas, or mixtures of gas and dust, and as showing the comparative fatal results of such accidents, the statistics for 1907 show that there were three times as many men killed as injured from this cause, whereas in the accidents from other causes the injuries which did not result fatally largely exceed the fatal ones. In the accidents from powder explosions and windy shots twice as many men were injured as killed, and this ratio obtains in the injuries received from falls of roof or coal. In the accidents from other causes nearly three times as many men were injured as were killed.

The month of December, 1907, was the black month of the year, there having been four different explosions in that month, which caused probably 80 per cent of this wholesale destruction of life. The first of these disasters occurred at the Naomi mine of the Naomi Coal Company, near Pittsburg, Pa. It occurred on the first day of the month, and is said to have been caused by the ignition of a pocket of gas from a naked lamp carried by a miner. This was followed in less than a week by the explosion at Monongah, which wrecked mines Nos. 6 and 8 of the Fairmont Coal Company. These mines were considered among the safest in the State of West Virginia, and the results of the explosion were the worst in the history of coal mining in the United States, the lives of between 350 and 400 men having been sacrificed. The cause of this explosion has not been definitely settled. It is supposed to have been due to a blown-out shot, but the actual cause will probably never be known. Ten days after the Monongah disaster, and while its horrors were still fresh, there occurred, on December 16, at Yolande, Ala., an explosion in mine No. 1 of the Yolande Coal and Coke Company, which resulted in the death of 56 men. This explosion, according to the report of Mr. J. M. Gray, the State mine inspector, was due to the ignition of coal dust by an accidental explosion of dynamite. Three days later, on December 19, the final great disaster occurred at the Darr mine, of the Pittsburg Coal Company, on Jacobs Creek, Pennsylvania. The number of men killed in this explosion was about 230, and according to the reports of the mine inspectors the explosion may have been due to any of three causes—the projection of flame into a gaseous and dusty atmosphere, the ignition of gas by open lights, or to an accidental explosion of dynamite. The coroner's jury attributed the explosion to the ignition of gas by an open lamp in the hands of a miner.

It has been said that there is only one way by which accidents in coal mines can be entirely prevented, and that is by ceasing to mine coal. There is no doubt, however, that the number of accidents may be greatly lessened, and much benefit in this regard is anticipated from the action of Congress in appropriating the sum of $150,000 to enable the United States Geological Survey to investigate the causes of mine explosions and make recommendations with regard thereto. It is not the intention, as it is not the province, of the Geological Survey to undertake any system of mine inspection or regulation, but simply to carry on research investigations, the results of which will be published for the benefit of all. The writer is of the opinion that one of the great needs in the coal-mining industry is the enforcement of military discipline in the operation of the mines. Without such discipline the knowledge acquired through investigation has proved of little avail.

For the figures contained in the following tables acknowledgments are due to the following officials: Mr. J. M. Gray, chief mine inspector, Alabama; Mr. R. A. Young, State inspector of mines, Arkansas; Mr. John D. Jones, State inspector of coal mines, Colorado; Mr. David

Ross, secretary of the bureau of labor statistics, Illinois; Mr. William Cameron, formerly United States mine inspector for Indian Territory; Messrs. John Verner, R. T. Rhys, and Edward Sweeney, inspectors of the first, second, and third mining districts of Iowa; Mr. C. J. Norwood, State mine inspector, Kentucky; Mr. Thomas Murphy, State mine inspector of Maryland; Mr. M. J. McLeod, commissioner of labor, Michigan; Mr. J. W. Marstellar, secretary bureau of mines, Missouri; Mr. J. B. McDermott, State coal-mine inspector, Montana; Mr. J. E. Sheridan, United States mine inspector, New Mexico; Mr. George Harrison, chief inspector of mines, Ohio; Mr. James E. Roderick, chief of the department of mines, Pennsylvania; Mr. J. E. Pettit, State coal-mine inspector, Utah; Mr. D. C. Botting, State inspector of coal mines, Washington; Mr. James W. Paul, chief department of mines, West Virginia; and Messrs. D. M. Elias and Noah Young, State mine inspectors, Wyoming.

In the 21 States and Territories from which returns were received in 1906 the total number of men killed was 2,092, while 4,800 men were injured. In the 18 States and Territories from which reports were received in 1907 there were 3,125 men killed and 5,316 injured. The death rate per 1,000 employees increased from 3.31 in 1906 to 4.86 in 1907, and the number of tons mined for each life lost decreased from 194,950 to 145,471. The State in which the lowest record in the death rate per 1,000 was made, in 1907, was Missouri, whose rate per thousand employees was 0.95, and there were 499,742 tons mined for each life lost. Michigan was second on the roll of honor as far as the death rate per thousand was concerned, and Kentucky was second in the number of tons mined for each life lost. The death rate in Michigan was 1.76 men killed per thousand employees. In Kentucky the death rate was 1.89, while Kentucky mined 336,035 tons for each life lost, and Michigan 290,837 tons. Arkansas reported a death rate of 1.97 in 1907, with 133,522 tons mined for each life lost, while Utah, with a death rate of 2.72, mined 324,601 tons for each life lost. West Virginia reported the largest death rate in 1907—12.35 per thousand, and the lowest production for each life lost, 65,969. New Mexico was second in this regard, with a death rate of 11.45 and 77,322 tons for each life lost. Alabama was third, with a death rate of 7.2 per thousand and 92,535 tons for each life lost.

On account of the prominence given by the press to the description of mine explosions when such disasters claim a number of victims, the opinion naturally held by the general public is that the danger from explosions is the greatest of the many to which the coal-mine workers are exposed. Statistics do not bear out this impression, as is shown in the table giving causes of accidents in the coal mines in 1906 and 1907. The danger from gas or dust explosions is a serious one, as shown by the record and by the reports of horrors which only too frequently are depicted in the columns of the daily press; but it appears that the number of deaths due to this cause was only 30 per cent of the total in 1907 and 11 per cent in 1906, and that there were in 1906 more than four times as many deaths due to falls of roof and coal than were due to explosions, whether of gas or dust or mixtures of these. The deaths due to falls of roof usually occur singly, and news of them seldom gets beyond the immediate vicinity of the mine in which the accident occurs, and yet in 1907, in spite of the large number of men killed by gas and dust explosions, more than one-third, or 1,122 out of 3,125, were killed by falls of roof or coal. In 1906, 1,008 men, out of a total of 2,092, or nearly 50 per cent, met death from this cause. The fatalities resulting from gas and dust explosions totaled 947 in 1907 against 228 in 1906. Powder explosions and windy shots claimed 201 lives in 1907 and 80 in 1906; 855 deaths were due to miscellaneous causes in 1907 and 732 in 1906.

*Fatal and nonfatal accidents in coal mines of the United States in 1906, by States and Territories.*

| State or Territory. | Number of men killed. | Number of men injured. | Death rate per 1,000 employees. | Number of tons mined for each life lost. |
|---|---|---|---|---|
| | | | | *Short tons.* |
| Alabama | 96 | 89 | 4.67 | 136,541 |
| Arkansas | 13 | 31 | 3.02 | 143,405 |
| Colorado | 88 | 160 | 7.74 | 114,900 |
| Illinois | 155 | 480 | 2.50 | 247,210 |
| Indiana | 31 | (a) | 1.47 | 390,083 |
| Indian Territory | 44 | 48 | 5.33 | 65,005 |
| Iowa | 37 | 116 | 2.42 | 196,384 |
| Kansas | 31 | 58 | 3.04 | 185,633 |
| Kentucky | 40 | 139 | 2.62 | 241,341 |
| Maryland | 7 | 52 | 1.09 | 776,493 |
| Michigan | 6 | 27 | 1.51 | 224,398 |
| Missouri | 16 | 27 | 1.68 | 233,221 |
| Montana | 13 | 46 | 5.43 | 140,763 |
| New Mexico | 9 | (a) | 3.82 | 199,359 |
| Ohio | 127 | 528 | 2.80 | 218,359 |
| Pennsylvania: | | | | |
| Anthracite | 557 | 1,212 | 3.43 | 127,976 |
| Bituminous | 477 | 1,160 | 3.14 | 271,055 |
| Tennessee | 33 | 210 | 2.88 | 189,675 |
| Utah | 7 | 21 | 4.45 | 253,222 |
| Washington | 22 | 76 | 4.86 | 148,917 |
| West Virginia | 268 | 299 | 5.65 | 156,313 |
| Wyoming | 15 | 21 | 2.53 | 408,933 |
| Total | 2,092 | 4,800 | 3.31 | 194,950 |

[a] Not reported.

*Fatal and nonfatal accidents in coal mines of the United States in 1907, by States and Territories.*

| State or Territory. | Number of men killed. | Number of men injured. | Death rate per 1,000 employees. | Number of tons mined for each life lost. |
|---|---|---|---|---|
| | | | | *Short tons.* |
| Alabama | 154 | 85 | 7.20 | 92,535 |
| Arkansas | [a] 10 | [a] 6 | 1.97 | 133,522 |
| Colorado | 99 | 138 | 6.96 | 108,992 |
| Illinois | 172 | 596 | 2.62 | 298,356 |
| Indiana | 53 | 451 | 2.52 | 263,881 |
| Iowa | 41 | 68 | 2.63 | 184,740 |
| Kansas | 32 | 48 | 2.57 | 228,827 |
| Kentucky | 32 | 86 | 1.89 | 336,035 |
| Maryland | ........ | ........ | ........ | ........ |
| Michigan | 7 | 47 | 1.76 | 290,837 |
| Missouri | 8 | 23 | .95 | 499,742 |
| Montana | 12 | 52 | 4.39 | 168,071 |
| New Mexico | 34 | ........ | 11.45 | 77,322 |
| North Dakota | ........ | ........ | ........ | ........ |
| Ohio | 153 | 662 | 3.27 | 210,081 |
| Oklahoma (Indian Territory) | 33 | 56 | 3.93 | 110,384 |
| Pennsylvania: | | | | |
| Anthracite | 708 | 1,369 | 4.23 | 120,910 |
| Bituminous | 806 | 1,207 | 4.94 | 186,281 |
| Tennessee | ........ | ........ | ........ | ........ |
| Utah | 6 | 82 | 2.72 | 324,601 |
| Washington | 36 | 95 | 6.06 | 102,237 |
| West Virginia | 729 | 245 | 12.35 | 65,969 |
| Wyoming | ........ | ........ | ........ | ........ |
| Total | 3,125 | 5,316 | 4.86 | 145,471 |

[a] For 6 months only.

*Causes of fatal and nonfatal accidents in coal mines in 1906.*

| State or Territory. | Gas and dust explosions. | | Powder explosions. | | Falls of roof and coal. | | Other causes. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. |
| Alabama | 13 | 20 | 4 | 14 | 50 | 34 | 29 | 21 | 96 | 89 |
| Arkansas | 6 | 2 | ...... | ...... | 7 | 18 | ...... | 11 | 13 | 31 |
| Colorado | 35 | 11 | 4 | 9 | 44 | 105 | 5 | 35 | 88 | 160 |
| Illinois | 2 | 7 | 12 | 24 | 84 | 258 | 57 | 191 | 155 | 480 |
| Indiana | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 31 | ...... |
| Indian Territory | 6 | 12 | 14 | 6 | 7 | 13 | 17 | 17 | 44 | 48 |
| Iowa | ...... | ...... | 3 | ...... | 24 | 62 | 10 | 54 | 37 | 116 |
| Kansas | ...... | ...... | 2 | 2 | 17 | 24 | 12 | 32 | 31 | 58 |
| Kentucky | 2 | 8 | 1 | 3 | 18 | 29 | 19 | 99 | 40 | 139 |
| Maryland | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 7 | 52 |
| Michigan | (a) | (a) | (a) | (a) | (a) | (a) | (a) | (a) | 6 | 27 |
| Missouri | ...... | ...... | ...... | 2 | 13 | 17 | 3 | 8 | 16 | 27 |
| Montana | ...... | 4 | ...... | ...... | 4 | 14 | 9 | 28 | 13 | 46 |
| New Mexico | ...... | ...... | ...... | ...... | 7 | (a) | 2 | ...... | 9 | ...... |
| Ohio | ...... | ...... | 7 | 33 | 80 | 173 | 40 | 178 | 127 | 528 |
| Pennsylvania: | | | | | | | | | | |
| Anthracite | 43 | 195 | 28 | 49 | 214 | 314 | 272 | 654 | 557 | 1,212 |
| Bituminous | 10 | 26 | 1 | 58 | 305 | 596 | 161 | 480 | 477 | 1,160 |
| Tennessee | 1 | ...... | 2 | 9 | 20 | 37 | 10 | 164 | 33 | 210 |
| Utah | 4 | ...... | ...... | ...... | 3 | 17 | ...... | 4 | 7 | 21 |
| Washington | 1 | 9 | ...... | ...... | 6 | 18 | 15 | 49 | 22 | 76 |
| West Virginia | 105 | 13 | 2 | 6 | 99 | 128 | 62 | 152 | 268 | 299 |
| Wyoming | ...... | ...... | ...... | ...... | 6 | 6 | 9 | 15 | 15 | 21 |
| Total | 228 | 307 | 80 | 215 | 1,008 | 1,863 | 732 | 2,192 | 2,092 | 4,800 |

[a] Not reported.

*Causes of fatal and nonfatal accidents in coal mines in 1907.*

| State or Territory. | Gas and dust explosions. | | Powder explosions and windy shots. | | Falls of roof or coal. | | Other causes. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. |
| Alabama | 62 | 7 | 5 | 13 | 24 | 22 | 63 | 43 | 154 | 85 |
| Arkansas[a] | 5 | 4 | 1 | ...... | 1 | 2 | 3 | ...... | 10 | 6 |
| Colorado | 25 | 5 | 3 | 6 | 52 | 80 | 19 | 47 | 99 | 138 |
| Illinois | 7 | 23 | 26 | 38 | 92 | 301 | 47 | 234 | 172 | 596 |
| Indiana | 2 | 16 | 18 | 33 | 16 | 153 | 17 | 249 | 53 | 451 |
| Iowa | 1 | ...... | 3 | 4 | 29 | 30 | 8 | 34 | 41 | 68 |
| Kansas | 9 | 5 | 1 | 9 | 17 | 22 | 5 | 12 | 32 | 48 |
| Kentucky | ...... | 8 | 2 | 12 | 12 | 19 | 18 | 47 | 32 | 86 |
| Maryland | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Michigan | 1 | ...... | 2 | ...... | 4 | 26 | ...... | 21 | 7 | 47 |
| Missouri | ...... | ...... | 1 | 1 | 6 | 19 | 1 | 3 | 8 | 23 |
| Montana | ...... | 3 | ...... | 1 | 7 | 33 | 5 | 15 | 12 | 52 |
| New Mexico[b] | 11 | ...... | ...... | ...... | 13 | ...... | 10 | ...... | 34 | ...... |
| North Dakota | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Ohio | 3 | 7 | 2 | 34 | 97 | 307 | 51 | 314 | 153 | 662 |
| Oklahoma (Ind. T.) | 6 | 23 | 11 | 8 | 11 | 15 | 5 | 10 | 33 | 56 |
| Pennsylvania: | | | | | | | | | | |
| Anthracite | 44 | 191 | 87 | 150 | 279 | 357 | 298 | 671 | 708 | 1,369 |
| Bituminous | 276 | 27 | 15 | 69 | 307 | 593 | 208 | 518 | 806 | 1,207 |
| Tennessee | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Utah | 1 | 4 | ...... | ...... | 3 | 26 | 2 | 52 | 6 | 82 |
| Washington | 10 | 20 | 1 | 4 | 8 | 32 | 17 | 39 | 36 | 95 |
| West Virginia | 484 | ...... | 23 | 34 | 144 | 104 | 78 | 107 | 729 | 245 |
| Wyoming | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Total | 947 | 343 | 201 | 416 | 1,122 | 2,141 | 855 | 2,416 | 3,125 | 5,316 |

[a] For 6 months only.

[b] Fatal accidents only reported.

In the following table is shown the number of fatal accidents in the coal mines of the United States, as far as the statistics have been obtained, from 1896 to 1907:

*Fatal accidents in coal mines in the United States from 1896 to 1907.*

| States. | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 28 | 38 | 45 | 40 | 37 | 41 | 50 | 57 | 84 | 185 | 96 | 154 |
| Arkansas | ...... | ...... | ...... | ...... | ...... | 18 | 13 | ...... | ...... | 8 | 13 | 10 |
| Colorado | 68 | 35 | 24 | 41 | 29 | 55 | 73 | 40 | 89 | 59 | 88 | 99 |
| Illinois | 77 | 69 | 72 | 84 | 94 | 99 | 99 | 156 | 157 | 199 | 155 | 172 |
| Indiana | 28 | 16 | 22 | 16 | 18 | 24 | 24 | 55 | 34 | 47 | 31 | 53 |
| Iowa | 22 | 21 | 26 | 20 | 29 | 26 | 55 | 21 | 31 | 24 | 37 | 41 |
| Kansas | 12 | 6 | 17 | 16 | 22 | 26 | 27 | 36 | [a] 16 | 36 | 31 | 32 |
| Kentucky | 6 | 12 | 6 | 7 | 17 | 21 | 19 | 25 | 19 | 31 | 40 | 32 |
| Maryland | 6 | 5 | 4 | 5 | 7 | 12 | 11 | 13 | 12 | 13 | 7 | ...... |
| Michigan | ...... | ...... | ...... | [a] 4 | 10 | 6 | 6 | 8 | 7 | 8 | 6 | 7 |
| Missouri | 16 | 8 | 9 | 14 | 10 | 15 | 10 | 17 | 11 | 11 | 16 | 8 |
| Montana | ...... | ...... | ...... | ...... | ...... | ...... | 12 | ...... | ...... | ...... | 13 | 12 |
| New Mexico | 7 | 7 | 7 | 15 | 15 | 9 | 17 | 17 | 15 | 5 | 9 | 34 |
| Ohio | 41 | 40 | 52 | 57 | 68 | 72 | 81 | 114 | 118 | 131 | 127 | 153 |
| Oklahoma (Indian Territory) | 12 | 22 | 17 | 25 | 40 | 44 | 60 | 33 | 30 | 40 | 44 | 33 |
| Pennsylvania: | | | | | | | | | | | | |
| Anthracite | 502 | 423 | 411 | 461 | 411 | 513 | 300 | 518 | 595 | 644 | 557 | 708 |
| Bituminous | 180 | 150 | 199 | 258 | 265 | 301 | 456 | 402 | 536 | 479 | 477 | 806 |
| Tennessee | 22 | 10 | 19 | 20 | 10 | 53 | 226 | 26 | 28 | 29 | 33 | ...... |
| Utah | 3 | 3 | 3 | ...... | 200 | 10 | 8 | 7 | 9 | 7 | 7 | 6 |
| Washington | 8 | 7 | 9 | 45 | 33 | 27 | 34 | 25 | 31 | 13 | 22 | 36 |
| West Virginia | 65 | 62 | 90 | 89 | 141 | 130 | 120 | 159 | 140 | 194 | 268 | 729 |
| Wyoming | ...... | ...... | ...... | ...... | ...... | 41 | 190 | ...... | ...... | 12 | 15 | ...... |
| Total | 1,103 | 934 | 1,032 | 1,217 | 1,465 | 1,543 | 1,891 | 1,729 | 1,962 | 2,175 | 2,092 | 3,125 |

[a] Six months only.

## QUANTITY OF COAL WASHED AT THE MINES IN 1907.

In collecting the statistics of coal production in 1906 and 1907 inquiries regarding the washing of bituminous coal were included in the schedules. Replies to these inquiries showed that 12,981,514 short tons of coal were washed in 1907, either before marketing or before being charged into the ovens for coking. In 1906 the quantity of coal washed was 10,425,455 short tons. The cleaned product from the washeries amounted to 11,269,518 short tons in 1907 and 9,251,946 tons in 1906, the refuse in the two years having been 1,711,996 and 1,173,509 tons, respectively. In Alabama, Georgia, Kentucky, Pennsylvania, Tennessee, West Virginia, and other coking coal-producing States a large portion of the coal washed was slack used in coke making, the returns form the coking plants having shown that in 1907 6,090,449 tons of slack coal were washed before being charged into the ovens, and the total amount of coal washed before coking, reported in 1907, was 11,680,184 short tons.

The statistics presented in the following tables include only the coal washed at the mines. A considerable portion of the coal used in coke making was washed at points distant from the mines. Colorado, for instance, reports 1,330,766 tons of coal washed for coke making, while only 39,655 tons were reported from that State as having been washed at the mines.

The statistics covering the production of Pennsylvania anthracite, by Mr. William W. Ruley, show that 4,301,082 long tons (equivalent to 4,817,212 short tons) were recovered by the washing of culm in

1907, against 3,846,501 long tons, or 4,308,081 short tons, in 1906. These figures are not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1906 and 1907.

*Bituminous coal washed at the mines in 1906, with quantity of washed coal and of refuse obtained from it, by States and Territories, in short tons.*

1906.

| State or Territory. | Number of jigs or washers. | Quantity of coal washed. | Quantity of coal obtained. | Quantity of refuse. |
|---|---|---|---|---|
| Alabama | 38 | 1,985,889 | 1,753,537 | 232,352 |
| Arkansas | 4 | 36,309 | 27,711 | 8,598 |
| Georgia | 3 | 106,850 | 101,563 | 5,287 |
| Illinois | 232 | 2,600,817 | 2,216,593 | 384,224 |
| Indiana | 4 | 16,589 | 14,793 | 1,796 |
| Indian Territory | 5 | 121,875 | 104,832 | 17,043 |
| Kentucky | 6 | 92,612 | 82,322 | 10,290 |
| Maryland | 1 | 5,227 | 4,704 | 523 |
| Missouri | 4 | 15,765 | 12,221 | 3,544 |
| Montana | 37 | 390,135 | 303,318 | 86,817 |
| New Mexico | 7 | 160,347 | 139,728 | 20,619 |
| Ohio | 17 | 85,169 | 74,441 | 10,728 |
| Pennsylvania | 171 | 2,851,034 | 2,689,304 | 161,730 |
| Tennessee | 10 | 739,531 | 675,454 | 64,077 |
| Virginia | 3 | 807 | 767 | 40 |
| Washington | 34 | 784,817 | 657,030 | 127,787 |
| West Virginia | 8 | 431,682 | 393,628 | 38,054 |
| Total | 584 | 10,425,455 | 9,251,946 | 1,173,509 |

1907.

| State or Territory. | Number of jigs or washers. | Quantity of coal washed. | Quantity of coal obtained. | Quantity of refuse. |
|---|---|---|---|---|
| Alabama | 82 | 4,193,545 | 3,750,418 | 443,127 |
| Arkansas | 4 | 92,848 | 69,636 | 23,212 |
| Colorado | 4 | 39,655 | 26,372 | 13,283 |
| Georgia | 6 | 147,683 | 136,031 | 11,652 |
| Illinois | 181 | 2,988,386 | 2,465,767 | 522,619 |
| Indiana | 4 | 23,825 | 21,659 | 2,166 |
| Kentucky | 6 | 99,763 | 88,678 | 11,085 |
| Maryland | 1 | 10,640 | 9,856 | 784 |
| Missouri | 4 | 103,181 | 72,227 | 30,954 |
| Montana | 31 | 338,869 | 253,060 | 85,809 |
| New Mexico | 3 | 306,292 | 287,785 | 18,507 |
| Ohio | 17 | 140,460 | 107,246 | 33,214 |
| Oklahoma (Indian Territory) | 14 | 92,710 | 80,871 | 11,839 |
| Oregon | 1 | 36,936 | 18,928 | 18,008 |
| Pennsylvania | 289 | 2,705,519 | 2,475,956 | 229,563 |
| Tennessee | 10 | 604,557 | 543,333 | 61,224 |
| Virginia | 7 | 33,886 | 29,386 | 4,500 |
| Washington | 40 | 799,015 | 644,501 | 154,514 |
| West Virginia | 8 | 223,744 | 187,808 | 35,936 |
| Total | 712 | 12,981,514 | 11,269,518 | 1,711,996 |

## PRICES.

The following tables show the fluctuations in the average prices prevailing in each State since 1903, and also the average prices for the total production of anthracite and bituminous coal in the United States since 1880. These averages are obtained by dividing the total product, including colliery consumption, into the total value. From these tables it appears that the highest average price for anthracite coal since 1880 was that recorded in 1903. The average prices for both anthracite and bituminous coal in 1903 were the highest in any year since 1881, inclusive. With only a few exceptions, prices advanced generally throughout the United States in 1907, this being due to the unprecedented demand which prevailed during the first 9½ months of the year. The exceptions to the rule of general advanced prices were Alabama and Illinois, in which the effect of the financial stress during October, November, and December overcame the effects of the higher prices in the earlier part of the year.

*Average price per short ton for coal at the mines since 1903, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | $1.22 | $1.20 | $1.21 | $1.34 | $1.29 |
| Arkansas | 1.51 | 1.54 | 1.49 | 1.61 | 1.68 |
| California | [a] 2.86 | [a] 4.74 | [a] 4.97 | [a] 2.55 | [a] 3.81 |
| Colorado | 1.23 | 1.31 | 1.22 | 1.26 | 1.40 |
| Georgia | [b] 1.26 | [b] 1.22 | [b] 1.29 | 1.28 | 1.38 |
| Idaho | 3.10 | [c] 3.95 | [c] 3.03 | [c] 3.93 | [d] 4.10 |
| Illinois | 1.17 | 1.10 | 1.06 | 1.08 | 1.07 |
| Indiana | 1.23 | 1.11 | 1.05 | 1.08 | 1.08 |
| Iowa | 1.65 | 1.61 | 1.56 | 1.60 | 1.62 |
| Kansas | 1.52 | 1.52 | 1.46 | 1.49 | 1.52 |
| Kentucky | 1.06 | 1.04 | .99 | 1.02 | 1.06 |
| Maryland | 1.48 | 1.19 | 1.14 | 1.19 | 1.20 |
| Michigan | 1.97 | 1.81 | 1.71 | 1.80 | 1.80 |
| Missouri | 1.61 | 1.63 | 1.58 | 1.63 | 1.64 |
| Montana | 1.64 | 1.61 | 1.72 | 1.77 | 1.94 |
| New Mexico | 1.37 | 1.31 | 1.33 | 1.34 | 1.46 |
| North Carolina | (e) | (e) | (e) | ........ | ........ |
| North Dakota | 1.50 | 1.43 | 1.34 | 1.54 | 1.61 |
| Ohio | 1.29 | 1.09 | 1.04 | 1.09 | 1.10 |
| Oklahoma (Indian Territory) | 1.82 | 1.82 | 1.76 | 1.92 | 2.04 |
| Oregon | 2.43 | 2.18 | 2.58 | 2.66 | 2.34 |
| Pennsylvania bituminous | 1.18 | .96 | .96 | 1.00 | 1.04 |
| Tennessee | 1.25 | 1.18 | 1.14 | 1.22 | 1.25 |
| Texas | 1.62 | 1.66 | 1.64 | 1.66 | 1.69 |
| Utah | 1.20 | 1.30 | 1.35 | 1.36 | 1.52 |
| Virginia | .96 | .86 | .88 | .98 | 1.02 |
| Washington | 1.69 | 1.63 | 1.79 | 1.80 | 2.09 |
| West Virginia | 1.17 | .88 | .86 | .95 | .99 |
| Wyoming | 1.24 | 1.30 | 1.31 | 1.31 | 1.56 |
| Total bituminous | 1.24 | 1.10 | 1.06 | 1.11 | 1.14 |
| Pennsylvania anthracite | 2.04 | 1.90 | 1.83 | 1.85 | 1.91 |
| General average | 1.41 | 1.26 | 1.21 | 1.24 | 1.28 |

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nebraska.
[d] Includes Nebraska and Nevada.
[e] Included in Georgia.

*Average price per short ton of coal in the United States for 28 years.*

| Year. | Anthracite. | Bituminous. | Year. | Anthracite. | Bituminous. |
|---|---|---|---|---|---|
| 1880 | $1.47 | $1.25 | 1894 | $1.51 | $0.91 |
| 1881 | 2.01 | 1.12 | 1895 | 1.41 | .86 |
| 1882 | 2.01 | 1.12 | 1896 | 1.50 | .83 |
| 1883 | 2.01 | 1.07 | 1897 | 1.51 | .81 |
| 1884 | 1.79 | .94 | 1898 | 1.41 | .80 |
| 1885 | 2.00 | 1.13 | 1899 | 1.46 | .87 |
| 1886 | 1.95 | 1.05 | 1900 | 1.49 | 1.04 |
| 1887 | 2.01 | 1.11 | 1901 | 1.67 | 1.05 |
| 1888 | 1.91 | 1.00 | 1902 | 1.84 | 1.12 |
| 1889 | 1.44 | .99 | 1903 | 2.04 | 1.24 |
| 1890 | 1.43 | .99 | 1904 | 1.90 | 1.10 |
| 1891 | 1.46 | .99 | 1905 | 1.83 | 1.06 |
| 1892 | 1.57 | .99 | 1906 | 1.85 | 1.11 |
| 1893 | 1.59 | .96 | 1907 | 1.91 | 1.14 |

## IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Statistics of the Department of Commerce and Labor, and show the imports and exports of coal from 1903 to 1907, inclusive. The values given in both cases are considerably higher than the average "spot" rates by which the values of the domestic production have been computed.

The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846 to 1857, 30 per cent ad valorem; 1857 to 1861, 24 per cent ad valorem; 1861, bituminous and shale, $1 per ton; all other, 50 cents per ton; 1862 to 1864, bituminous and shale, $1.10 per ton; all other, 60 cents per ton; 1864 to 1872, bituminous and shale, $1.25 per ton; all other, 40 cents per ton. By the act of 1872 the tariff on bituminous coal and shale was made 75 cents per ton, and so continued until the act of August, 1894, changed it to 40 cents per ton. On slack or culm the tariff was made 40 cents per ton by the act of 1872; was changed to 30 cents per ton by the act of March, 1883, and so continued until the act of August, 1894, changed it to 15 cents per ton. The tariff act of 1897 provided that all coals which contain less than 92 per cent fixed carbon, and which will pass over a half-inch screen, shall pay a duty of 67 cents per ton. Slack or culm was not changed by the act of 1897. Tons are all 2,240 pounds. Anthracite coal has been free of duty since 1870. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions in North America was admitted into the United States duty free. A special act of Congress placed all the coal on the free list for one year from January 1, 1903, in order to relieve the shortage caused by the anthracite strike of 1902.

The exports consist of anthracite and bituminous coal, the quantity of bituminous being the greater in the last few years. They are made principally by rail over the international bridges and by lake and sea to the Canadian provinces. Exports are also made by sea to the West Indies, to Central and South America, and elsewhere.

The imports are principally from Australia and British Columbia to San Francisco, from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast points.

The total exports of coal from the United States during 1907 were 13,146,748 long tons, valued at $40,190,893, of which 2,698,072 long tons, valued at $13,217,985, were anthracite, and 10,448,676 long tons, valued at $26,972,908, were bituminous coal. The imports of anthracite amounted in 1907 to 9,897 long tons, valued at $40,971, and those of bituminous coal to 2,103,711 long tons, valued at $5,397,222. From this it can be seen that the imports of anthracite coal into the United States are relatively of no importance. Most of the anthracite imported is to San Francisco and other points on the Pacific coast, being brought in principally as ballast in vessels coming for outgoing cargoes. The principal increase has been in the imports of bituminous coal during the last four or five years. This has been due to the receipts of Nova Scotia coal at Everett, Mass., that fuel being used in the manufacture of coke in the retort-oven plant of the New England Gas and Coke Company at that place. Compared with the domestic production, the total quantity of coal imported into the United States is of little consequence, having for years averaged less than 1 per cent of the production.

*Coal of domestic production exported from the United States, 1903-1907, in long tons.*

| Year. | Anthracite. | | Bituminous and shale. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| 1903 | 2,008,857 | $9,780,044 | 6,303,241 | $17,410,385 |
| 1904 | 2,228,392 | 11,077,470 | 6,345,126 | 17,160,538 |
| 1905 | 2,229,983 | 11,104,654 | 6,959,265 | 17,867,964 |
| 1906 | 2,216,969 | 10,896,200 | 7,704,850 | 19,787,459 |
| 1907 | 2,698,072 | 13,217,985 | 10,448,676 | 26,972,908 |

*Coal imported and entered for consumption in the United States, 1903-1907, in long tons.*

| Year. | Anthracite. | | Bituminous and shale. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| 1903 | [a] 175,747 | $792,657 | [b] 3,293,583 | $9,319,567 |
| 1904 | 72,529 | 220,664 | [b] 1,550,751 | 3,895,469 |
| 1905 | 34,241 | 107,314 | [b] 1,611,002 | 3,903,765 |
| 1906 | 32,354 | 105,161 | [b] 1,702,799 | 4,102,355 |
| 1907 | 9,897 | 40,971 | 2,103,711 | 5,397,222 |

[a] Includes 93,571 tons of anthracite containing less than 92 per cent fixed carbon, duty free under the special act of 1902, imported in 1902, and 28,041 tons imported in 1903.

[b] Includes 767,582 tons of slack or culm passing ½-inch screen imported in 1902, 577,274 tons imported in 1903, 579,204 tons imported in 1904, 611,053 tons imported in 1905, and 659,486 tons imported in 1906.

## WORLD'S PRODUCTION OF COAL.

In the following table is given the coal production of the principal countries for the years nearest the one under review for which figures could be obtained. For the sake of convenience the quantities are expressed in the unit of measurement adopted in each country and reduced for comparison to short tons of 2,000 pounds. In each case the year is named for which the production is given. It will be observed that the United States produced 39.7 per cent of the total world's supply of coal; that this country in 1907 produced 180,392,747 short tons, or 60 per cent, more coal than Great Britain, and 253,589,819 short tons, or over 100 per cent, more than Germany. Exclusive of Great Britain, the United States in 1907 produced more coal than all of the other countries of the world combined. It may also be noted that more than 98 per cent of the total world's production of coal is from countries lying north of the equator, the countries south of that line contributing less than 20 000 000 tons annually.

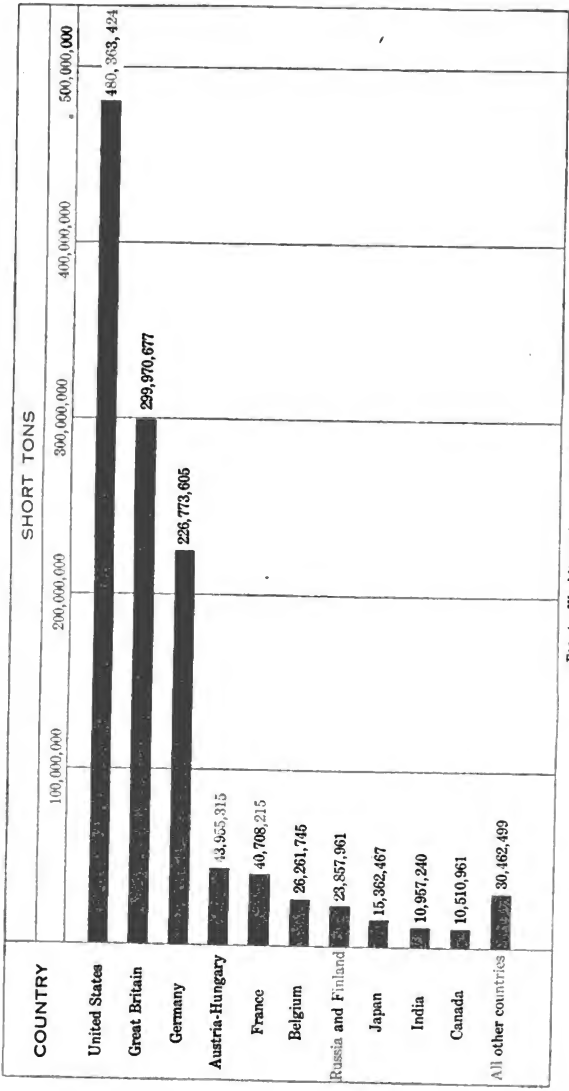

FIG. 4.—World's production of coal.

*The world's production of coal.*

| Country. | Usual unit in producing country. | Equivalent in short tons. |
|---|---|---|
| United States (1907) long tons | 428,973,251 | 480,363,424 |
| Great Britain (1907) do | 267,830,962 | 299,970,677 |
| Germany (1907) metric tons | 205,727,665 | 226,773,605 |
| Austria-Hungary (1907) do | 39,876,000 | 43,955,315 |
| France (1907) do | 36,930,250 | 40,708,215 |
| Belgium (1907) do | 23,824,499 | 26,261,745 |
| Russia and Finland (1906) do | 21,643,800 | 23,857,961 |
| Japan (1907) do | 13,935,952 | 15,362,467 |
| India (1906) long tons | 9,783,250 | 10,957,240 |
| Canada (1907) short tons | 10,510,961 | 10,510,961 |
| New South Wales (1906) long tons | 7,626,362 | 8,541,525 |
| Spain (1906) metric tons | 3,284,576 | 3,620,588 |
| Transvaal (1907)[a] long tons | 2,912,083 | 3,261,533 |
| New Zealand (1906) do | 1,729,536 | 1,937,080 |
| Natal (1905) do | 1,129,460 | 1,264,995 |
| Mexico (1906) metric tons | 767,864 | 846,416 |
| Queensland (1907) long tons | 683,272 | 765,265 |
| Holland (1906) metric tons | 532,780 | 587,283 |
| Italy (1906) do | 473,293 | 521,711 |
| Sweden (1906) do | 296,980 | 327,361 |
| Victoria (1906) long tons | 160,631 | 179,907 |
| Cape Colony (1906) do | 127,569 | 142,877 |
| Tasmania (1907) do | 58,891 | 65,958 |
| Other countries[b] do | 7,500,000 | 8,400,000 |
| Total |  | 1,209,184,109 |
| Percentage of the United States |  | 39.7 |

[a] Year ended June 30, 1907.

[b] Includes China, Turkey, Servia, Portugal, United States of Colombia, Chile, Borneo and Labuan, Peru, Greece, etc.

The growth of the coal-mining industry in the United States compared with that of the other countries of the world since 1868 is shown in the following table. From this it appears that during this period of 40 years the percentage of the world's total produced by the United States has increased from 14.32 to 39.73, and since 1899 the United States has held first place among the world's coal producers. It now stands far in the lead of all others. Although it is only 9 years since the United States supplanted Great Britain as the leading coal producer of the world, this country has now so outdistanced Great Britain that it can no longer be considered a competitor.

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*World's production of coal, by countries, 1868–1907.*

| Year. | United States. | | Great Britain. | | Germany. | |
|---|---|---|---|---|---|---|
| | Long tons. | Short tons. | Long tons. | Short tons. | Metric tons. | Short tons. |
| 1868 | 29,341,036 | 32,861,960 | 103,141,157 | 115,518,096 | 32,879,123 | 36,249,233 |
| 1869 | 29,378,893 | 32,904,360 | 107,427,557 | 120,318,864 | 34,343,913 | 37,864,164 |
| 1870 | 29,496,054 | 33,035,580 | 110,431,192 | 123,682,935 | 34,003,004 | 37,488,312 |
| 1871 | 41,861,679 | 46,885,080 | 117,352,028 | 131,434,271 | 37,856,110 | 41,736,361 |
| 1872 | 45,940,535 | 51,453,399 | 123,497,316 | 138,316,994 | 42,324,467 | 46,662,725 |
| 1873 | 51,430,786 | 57,602,480 | 128,680,131 | 144,121,747 | 46,145,194 | 50,875,076 |
| 1874 | 46,969,571 | 52,605,920 | 126,590,108 | 141,780,921 | 46,658,145 | 51,440,605 |
| 1875 | 46,739,571 | 52,348,320 | 133,306,485 | 149,303,263 | 47,804,054 | 52,703,970 |
| 1876 | 47,571,429 | 53,280,000 | 134,125,166 | 150,220,186 | 49,550,461 | 54,629,383 |
| 1877 | 54,019,429 | 60,501,760 | 134,179,968 | 150,281,564 | 48,229,882 | 53,173,445 |
| 1878 | 51,728,214 | 57,935,600 | 132,612,063 | 148,525,511 | 50,519,899 | 55,698,188 |
| 1879 | 60,808,749 | 68,105,799 | 133,720,393 | 149,766,840 | 53,470,716 | 58,951,464 |
| 1880 | 63,822,830 | 71,481,570 | 146,969,409 | 164,605,738 | 59,118,035 | 65,177,634 |
| 1881 | 76,679,491 | 85,881,030 | 154,184,300 | 172,686,416 | 61,540,485 | 67,848,385 |
| 1882 | 92,456,419 | 103,551,189 | 156,499,977 | 175,279,974 | 65,378,211 | 72,079,478 |
| 1883 | 103,310,290 | 115,707,525 | 163,737,327 | 183,385,806 | 70,442,648 | 77,663,019 |
| 1884 | 107,281,742 | 120,155,551 | 160,757,779 | 180,048,712 | 72,113,820 | 79,505,487 |
| 1885 | 99,250,263 | 111,160,295 | 159,351,418 | 178,473,588 | 73,675,515 | 81,227,255 |
| 1886 | 101,500,381 | 113,680,427 | 157,518,482 | 176,420,700 | 73,682,584 | 81,235,049 |
| 1887 | 116,652,242 | 130,650,511 | 162,119,812 | 181,574,189 | 76,232,618 | 84,046,461 |
| 1888 | 132,731,837 | 148,659,657 | 169,935,219 | 190,327,445 | 81,960,083 | 90,360,902 |
| 1889 | 126,097,779 | 141,229,513 | 176,916,724 | 198,146,731 | 84,973,230 | 93,640,500 |
| 1890 | 140,866,931 | 157,770,963 | 181,614,288 | 203,408,003 | 89,290,834 | 98,398,500 |
| 1891 | 150,505,954 | 168,566,669 | 185,479,126 | 207,736,621 | 94,252,278 | 103,913,136 |
| 1892 | 160,115,242 | 179,329,071 | 181,786,871 | 203,601,296 | 92,544,050 | 102,029,815 |
| 1893 | 162,814,977 | 182,352,774 | 167,325,795 | 184,044,890 | 95,426,153 | 105,207,334 |
| 1894 | 152,447,791 | 170,741,526 | 188,277,525 | 210,870,828 | 98,805,702 | 108,883,884 |
| 1895 | 172,426,366 | 193,117,530 | 189,661,362 | 212,320,725 | 103,957,639 | 114,561,318 |
| 1896 | 171,416,390 | 191,986,357 | 195,361,260 | 218,804,611 | 112,471,106 | 123,943,159 |
| 1897 | 178,776,070 | 200,229,199 | 202,129,931 | 226,385,523 | 120,474,485 | 132,762,882 |
| 1898 | 196,407,382 | 219,976,267 | 202,054,516 | 226,301,058 | 130,928,490 | 144,283,196 |
| 1899 | 226,554,635 | 253,741,192 | 220,094,781 | 246,506,155 | 135,824,427 | 149,719,766 |
| 1900 | 240,789,310 | 269,684,027 | 225,181,300 | 252,203,056 | 149,551,000 | 164,805,202 |
| 1901 | 261,874,836 | 293,299,816 | 219,046,945 | 245,332,578 | 152,628,931 | 168,217,082 |
| 1902 | 269,277,178 | 301,590,439 | 227,095,042 | 254,346,447 | 150,436,810 | 165,826,496 |
| 1903 | 319,068,229 | 357,356,416 | 230,334,469 | 257,974,605 | 162,457,253 | 179,076,630 |
| 1904 | 314,121,784 | 351,816,398 | 232,428,272 | 260,319,665 | 169,450,583 | 186,785,378 |
| 1905 | 350,645,210 | 392,722,635 | 236,128,936 | 264,464,408 | 173,796,674 | 191,576,074 |
| 1906 | 369,783,284 | 414,157,278 | 251,067,628 | 281,195,743 | 201,715,074 | 222,350,526 |
| 1907 | 428,895,914 | 480,363,424 | 267,830,962 | 299,970,677 | 205,727,665 | 226,773,605 |

*World's production of coal, by countries, 1868–1907*—Continued.

| Year. | Austria-Hungary. | | France. | | Belgium. | |
|---|---|---|---|---|---|---|
| | Metric tons. | Short tons. | Metric tons. | Short tons. | Metric tons. | Short tons |
| 1868 | 7,021,756 | 7,741,486 | 13,330,826 | 14,697,236 | 12,298,589 | 13,559,194 |
| 1869 | 7,663,043 | 8,448,505 | 13,509,745 | 14,894,494 | 12,943,994 | 14,270,753 |
| 1870 | 8,355,945 | 9,212,429 | 13,179,788 | 14,530,716 | 13,697,118 | 15,101,073 |
| 1871 | 8,437,401 | 9,302,235 | 13,240,135 | 14,597,249 | 13,733,176 | 15,140,827 |
| 1872 | 8,825,896 | 9,730,550 | 16,100,773 | 17,751,102 | 15,658,948 | 17,263,990 |
| 1873 | 10,104,769 | 11,140,508 | 17,479,341 | 19,270,973 | 15,778,401 | 17,395,687 |
| 1874 | 12,631,364 | 13,926,079 | 16,907,913 | 18,640,974 | 14,669,029 | 16,172,604 |
| 1875 | 13,062,738 | 14,395,137 | 16,956,840 | 18,694,916 | 15,011,331 | 16,549,992 |
| 1876 | 13,000,000 | 14,327,300 | 17,101,448 | 18,854,346 | 14,329,578 | 15,798,360 |
| 1877 | 13,500,000 | 14,883,750 | 16,804,529 | 18,526,993 | 13,669,077 | 15,070,157 |
| 1878 | 13,900,000 | 15,324,750 | 16,960,916 | 18,699,410 | 14,899,175 | 16,426,340 |
| 1879 | 14,500,000 | 15,986,250 | 17,110,979 | 18,864,854 | 15,447,292 | 17,030,640 |
| 1880 | 14,800,000 | 16,317,000 | 19,361,564 | 21,346,124 | 16,886,698 | 18,617,585 |
| 1881 | 15,304,813 | 16,873,556 | 19,765,983 | 21,791,996 | 16,873,951 | 18,603,531 |
| 1882 | 15,555,292 | 17,149,709 | 20,603,704 | 22,715,584 | 17,590,989 | 19,394,065 |
| 1883 | 17,047,961 | 18,795,377 | 21,333,884 | 23,520,607 | 18,177,754 | 20,040,974 |
| 1884 | 18,000,000 | 19,845,000 | 20,023,514 | 22,075,924 | 18,051,499 | 19,901,778 |
| 1885 | 20,435,463 | 22,530,098 | 19,510,530 | 21,510,359 | 17,437,603 | 19,224,957 |
| 1886 | 20,779,441 | 22,909,334 | 19,909,894 | 21,950,658 | 17,285,543 | 19,057,311 |
| 1887 | 21,879,172 | 24,121,787 | 21,287,589 | 23,469,567 | 18,378,624 | 20,262,433 |
| 1888 | 23,859,608 | 26,305,218 | 22,602,894 | 24,919,691 | 19,218,481 | 21,188,375 |
| 1889 | 25,328,417 | 27,924,580 | 24,303,509 | 26,794,619 | 19,869,980 | 21,906,653 |
| 1890 | 27,504,032 | 30,323,195 | 26,083,118 | 28,756,638 | 20,365,960 | 22,453,471 |
| 1891 | 28,823,240 | 31,777,622 | 26,024,893 | 28,692,444 | 19,675,644 | 21,692,398 |
| 1892 | 29,037,978 | 32,014,371 | 26,178,701 | 28,862,018 | 19,583,173 | 21,590,448 |
| 1893 | 30,449,304 | 33,570,358 | 25,650,981 | 28,280,207 | 19,410,519 | 21,400,097 |
| 1894 | 31,492,000 | 34,704,184 | 27,459,137 | 30,273,699 | 20,458,827 | 22,555,857 |
| 1895 | 32,654,777 | 35,985,564 | 28,019,893 | 30,877,922 | 20,450,604 | 22,536,566 |
| 1896 | 33,676,411 | 37,111,405 | 29,189,900 | 32,167,270 | 21,252,370 | 23,420,112 |
| 1897 | 35,858,000 | 39,515,516 | 30,797,629 | 33,938,987 | 21,534,629 | 23,731,161 |
| 1898 | 37,786,963 | 41,652,569 | 32,356,104 | 35,656,426 | 22,075,093 | 24,326,752 |
| 1899 | 38,739,000 | 42,690,378 | 32,863,000 | 36,215,026 | 21,917,740 | 24,159,925 |
| 1900 | 39,029,729 | 43,010,761 | 33,404,298 | 36,811,536 | 23,462,817 | 25,856,024 |
| 1901 | 41,202,302 | 45,417,959 | 32,301,757 | 35,596,536 | 22,213,410 | 24,485,842 |
| 1902 | 39,479,560 | 43,518,319 | 30,196,994 | 33,286,146 | 22,877,470 | 25,217,835 |
| 1903 | 40,628,785 | 44,772,921 | 34,906,418 | 38,466,873 | 23,796,680 | 26,223,941 |
| 1904 | 41,014,182 | 45,209,933 | 34,167,966 | 37,663,349 | 22,761,430 | 25,089,924 |
| 1905 | 42,994,240 | 47,392,551 | 35,336,442 | 38,951,360 | 21,844,200 | 24,078,862 |
| 1906 | 45,838,137 | 50,527,288 | 34,313,645 | 37,823,931 | 23,610,740 | 26,026,119 |
| 1907 | 39,876,000 | 43,955,315 | 36,930,250 | 40,708,215 | 23,824,499 | 26,261,745 |

*World's production of coal, by countries, 1868-1907*—Continued.

| Year. | Russia. | | Japan. | | Other countries. | Total. | Per cent of United States. |
|---|---|---|---|---|---|---|---|
| | Metric tons. | Short tons. | Metric tons. | Short tons. | Short tons. | Short tons. | |
| 1868 | 430,032 | 473,895 | ........ | ........ | 1,147,330 | 222,248,430 | 14.79 |
| 1869 | 579,419 | 638,510 | ........ | ........ | 1,104,563 | 230,444,213 | 14.28 |
| 1870 | 667,806 | 735,922 | ........ | ........ | 1,063,121 | 234,850,088 | 14.07 |
| 1871 | 772,371 | 851,153 | ........ | ........ | 1,114,248 | 261,061,424 | 17.96 |
| 1872 | 1,037,611 | 1,143,447 | ........ | ........ | 1,268,115 | 283,590,322 | 18.14 |
| 1873 | 1,154,618 | 1,272,389 | ........ | ........ | 1,502,516 | 303,181,376 | 19.00 |
| 1874 | 1,270,889 | 1,400,520 | ........ | ........ | 2,708,756 | 298,676,379 | 17.61 |
| 1875 | 1,673,753 | 1,844,475 | ........ | ........ | 2,639,104 | 308,479,177 | 16.97 |
| 1876 | 1,795,146 | 1,968,251 | ........ | ........ | 2,597,143 | 311,674,969 | 17.09 |
| 1877 | 1,760,276 | 1,939,824 | ........ | ........ | 2,821,155 | 317,198,648 | 19.07 |
| 1878 | 2,483,575 | 2,738,141 | ........ | ........ | 3,176,050 | 318,523,960 | 18.19 |
| 1879 | 2,874,790 | 3,169,456 | ........ | ........ | 3,362,605 | 335,237,908 | 20.32 |
| 1880 | 3,238,470 | 3,570,413 | ........ | ........ | 3,621,342 | 369,413,780 | 20.62 |
| 1881 | 3,439,787 | 3,792,365 | ........ | ........ | 5,185,974 | 392,663,253 | 21.87 |
| 1882 | 3,672,782 | 4,049,242 | ........ | ........ | 6,128,631 | 420,082,472 | 24.58 |
| 1883 | 3,916,105 | 4,317,506 | 1,021,000 | 1,125,142 | 6,929,841 | 450,990,397 | 25.55 |
| 1884 | 3,860,689 | 4,266,332 | 1,159,000 | 1,277,218 | 7,367,309 | 454,022,811 | 26.37 |
| 1885 | 4,207,905 | 4,639,215 | 1,314,000 | 1,448,028 | 7,570,507 | 447,783,802 | 24.82 |
| 1886 | 4,506,027 | 4,967,895 | 1,402,000 | 1,545,004 | 9,082,815 | 450,848,793 | 25.22 |
| 1887 | 4,464,174 | 4,921,752 | 1,785,000 | 1,967,070 | 10,399,273 | 481,412,743 | 27.14 |
| 1888 | 5,187,312 | 5,719,011 | 2,044,000 | 2,252,488 | 11,493,176 | 521,225,803 | 28.52 |
| 1889 | 6,215,577 | 6,852,674 | 2,435,000 | 2,683,370 | 12,618,299 | 531,797,039 | 26.56 |
| 1890 | 6,016,525 | 6,633,219 | 2,653,000 | 2,923,606 | 13,025,637 | 563,693,232 | 27.99 |
| 1891 | 6,233,020 | 6,871,905 | 3,230,000 | 3,559,460 | 14,744,329 | 587,554,583 | 28.69 |
| 1892 | 6,816,323 | 7,514,996 | 3,228,000 | 3,557,256 | 14,998,633 | 593,497,904 | 30.22 |
| 1893 | 7,535,000 | 8,307,337 | 3,350,000 | 3,691,700 | 15,783,599 | 582,638,296 | 31.30 |
| 1894 | 8,629,000 | 9,509,158 | 4,311,000 | 4,750,722 | 18,197,510 | 610,487,368 | 27.97 |
| 1895 | 9,079,138 | 10,005,210 | 4,849,000 | 5,343,598 | 19,428,643 | 644,177,076 | 29.98 |
| 1896 | 9,229,000 | 10,170,358 | 5,019,690 | 5,531,698 | 20,866,748 | 664,001,718 | 28.92 |
| 1897 | 11,207,475 | 12,350,638 | 5,647,751 | 6,225,516 | 22,074,093 | 697,213,515 | 28.72 |
| 1898 | 12,307,450 | 13,562,810 | 6,761,301 | 7,572,657 | 24,797,873 | 738,129,608 | 29.80 |
| 1899 | 13,562,810 | 15,730,346 | 6,716,831 | 7,401,948 | 25,811,285 | 801,976,021 | 31.63 |
| 1900 | 16,151,557 | 17,799,016 | 7,429,457 | 8,187,262 | 27,684,964 | 846,041,848 | 31.88 |
| 1901 | 16,269,800 | 17,934,201 | 8,945,938 | 9,861,107 | 30,565,923 | 870,711,044 | 33.69 |
| 1902 | 15,259,674 | 17,090,835 | 9,701,682 | 10,691,254 | 37,907,163 | 888,453,950 | 33.95 |
| 1903 | 17,818,000 | 19,640,781 | 10,088,845 | 11,120,934 | 37,562,430 | 972,195,531 | 36.76 |
| 1904 | [a] 19,318,370 | 21,294,639 | 10,772,240 | 11,874,240 | 43,332,409 | 983,527,562 | 35.78 |
| 1905 | [a] 17,233,871 | 18,996,896 | 11,630,000 | 12,819,749 | 45,478,314 | 1,034,156,604 | 37.98 |
| 1906 | 21,613,800 | 23,857,961 | 12,980,103 | 14,307,968 | [b] 47,898,532 | [c] 1,106,478,707 | 37.43 |
| 1907 | ........ | ........ | 13,935,952 | 15,362,467 | [b] 51,930,700 | [c] 1,209,184,109 | 39.73 |

[a] These figures also include the production of Finland.

[b] This includes the output of Canada (1907, 10,510,961 short tons); India (1906, 10,957,240 short tons); New South Wales (1906, 8,541,525 short tons); Spain (1906, 3,620,588 short tons); South African Republic (1907, 3,261,533 short tons); New Zealand (1906, 1,937,080 tons); Sweden (1906, 327,361 tons); Italy (1906, 521,711 tons); Queensland (1907, 765,265 tons); also that of Holland, Natal, Cape Colony, Tasmania, Mexico, and Victoria; and of China, Turkey, Servia, Portugal, etc. (estimated), 8,400,000 tons.

[c] Latest available figures are used in making up totals for 1907.

## COAL TRADE REVIEW.

Aside from the unprecedented tonnage and high prices which made the year 1907 a notable one in the history of coal mining in the United States, and which have been fully discussed in the preceding pages of this report, the principal feature of the year was the almost entire freedom from any protracted idleness due to labor disturbances. There were, of course, some cases of dissatisfaction and shut downs from strikes, but while these were annoying to those directly interested they were not of sufficient extent or sufficiently prolonged to affect the industry as a whole. The millennium in coal mining has not arrived, and so long as coal is mined so long will deaths and injuries from accidents occur, so also will there be some cases of strikes or lockouts. But taken all in all the year 1907 was an unusually peaceful one and made an enviable record in this regard. The year 1907 was in fact, notwithstanding the depression which followed the monetary troubles in October, one of the most, if not the most, satisfactory and profitable one ever recorded. Wages were generally high, but in spite of this labor during the first nine months was hard to get, largely because of the extraordinary demand in other and less exacting fields of employment. There was the usual complaint of insufficient car supply, but even in this conditions were improved over preceding years.

The prosperous condition of the coal-mining business has, however, been somewhat discounted by the opening up of many new mines in all of the important coal-producing States, although if fully manned and equipped the already developed properties would be well able to take care of even a larger demand than that which resulted in the production of nearly half a billion tons in 1907. The reaction from the somewhat inflated condition which began in October and which has continued up to the time of writing this report (July, 1908) will be somewhat more severely felt because of the new mines opened during the period of "flush times." The year 1908 began under prospects quite different from those which have characterized the coal-mining industry during recent years.

Following the usual custom, the coal-trade review feature of this report is given up principally to contributions prepared by secretaries of boards of trade or by other local authorities in the chief cities of consumption. These contributions will be found in the succeeding pages.

## NEW YORK CITY.

The following review of the coal trade of New York City has been prepared for this report by Mr. Frederick Hobart, associate editor of the Engineering and Mining Journal:

The local coal trade of New York was active and strong through almost the entire year 1907. The financial collapse of October, which affected all other branches of trade so swiftly, was slow in making itself felt in the coal trade, and it was close to the end of the year before business began to fall off; even then it was only in the demand for steam coals that there was any marked decrease.

In the city trade there were no marked changes in methods of delivery or in the character of the supply. One important point in the New York market is the lack of storage facilities in the city and the consequent dependence upon current receipts—it might almost be said, upon the daily receipts. This caused trouble during the year from time to time. No change can be expected in this condition, however, as it is the result of lack of space and the high cost of real estate. The activity of railroad business and the necessity of keeping everything moving in order to meet traffic demands prevented dealers from making as much use as usual of cars and barges for storage, and caused serious friction between railroads and consignees. Twice, especially, the Pennsylvania and other roads were forced to declare embargoes on coal traffic and to refuse to take coal from mines unless it could be shown that consignees were ready to unload the cars promptly at tidewater.

The New York market, it must be remembered, handles not only the coal for the city itself, but for a large suburban district, and for a considerable territory in southern and western New England, while much coal passes over the New York Harbor docks which goes by water as far as the Maine ports. Conditions in the harbor are therefore affected more or less by those at comparatively remote points.

The improvements on the Pennsylvania and Long Island railroads, which will facilitate and cheapen the delivery of coal materially in the boroughs of Brooklyn and Queens, and to a lesser extent in the Bronx also, made some progress during the year, but it will be another year before they can be fully utilized. In the borough of Manhattan nearly all the coal is received by water, chiefly in barges from the docks on the New Jersey shore. The distribution is by wagon from the yards, most of which are on the water front. There seems to be no present alternative for this rather costly and inefficient system, for which the consumer has to pay. In recent years, however, the location of most of the large power plants and electric plants on the water front, where coal can be transferred directly to the bins from the barges, without the intermediary of the horse and wagon, has been an important feature.

Beyond the building of one or two new piers there was no change in the chain of coal receiving and shipping docks which stretches along the New Jersey shore from South Amboy through Perth Amboy, Elizabethport, Port Johnson, Communipaw, Jersey City, and Hoboken, to Weehawken. At times during the year these docks and the adjoining yards were crowded to congestion. It was partly to relieve this congestion, but more to save the cost and delay of the ferry transfer from Jersey City to Port Morris that the New York, New Haven and Hartford Company in November withdrew all through rates on coal to New England points by way of New York Harbor, and insisted that coal to New England points on its line must be routed by Harrisburg, Easton, or Greycourt and the Poughkeepsie Bridge Line. The full effect of this change had not been realized at the close of the year.

As in previous years, it has been impossible to ascertain with any approach to accuracy the coal consumption of New York itself. There is no accessible record of deliveries to or in the city, and the railroads do not make public any figures, although they must have some data. Repeated efforts to secure the necessary information have failed. The Bureau of Statistics of the Department of Commerce and Labor reports the coastwise shipments of coal from the New York Harbor ports for two years past as follows:

*Coastwise shipments from New York Harbor ports, 1906–7.*

| | 1906. | 1907. | Increase. |
|---|---|---|---|
| Anthracite | 14,150,811 | 16,753,914 | 2,603,103 |
| Bituminous | 10,572,464 | 11,691,101 | 1,118,637 |
| Total | 24,723,275 | 28,445,015 | 3,721,740 |

The destinations of these shipments are not ascertained or given in the reports.

*Anthracite.*—The anthracite trade at the opening of the year was rather quiet, owing to the mild weather which had prevailed up to that time and which had limited the consumption of the prepared sizes for domestic use. Colder weather in January stimulated trade, and severe storms coming early in February caused a sudden demand, at the same time interfering seriously with railroad transportation and deliveries, so that at one time there was almost a scarcity of coal. Thereafter the winter, while comparatively free from very severe cold, showed a continuance of low temperatures which brought about a steady demand for domestic coal. A late, cold spring served to balance the mildness of the earlier part of the winter, so that domestic sales were well up to the average.

The April discount of 50 cents from list prices, with the gradually decreasing scale of discounts till September, did not stimulate the ordering of domestic supplies as much as usual. The reasons for this are not apparent on the surface. Some dealers say that it was due to the general prosperity and abundance of money, which caused disregard of smaller economies. Others did not agree with this reasoning, but failed to find any satisfactory explanation.

A mild fall was interrupted by some cold weather, which brought about satisfactory buying, and trade continued at a fair average up to the end of the year, being little affected by the financial disturbances. For domestic coal New York is eminently a weather market, and sales are largely controlled by the thermometer. The mildness or severity of the weather has much more influence on sales than financial conditions.

The feature of the trade was the large and steady demand for the small or steam sizes. These sizes are used by factories, by the electric light and power plants, and by the constantly increasing number of large buildings, both business and residential, which are heated from a central plant. All of these use the small sizes. At times during the year there was almost a scarcity of small coal, and at no time was there any considerable surplus available. Even in December, when many factories were closed, or running on short time, there was a demand which absorbed supplies readily.

Upon the whole the anthracite trade for the year was good, and sellers had little or no cause of complaint at the results. The anthracite carriers suffered comparatively little from car shortage, mainly for the reason that their cars are more directly under their own control than is the case with the bituminous roads, while the haul on anthracite to tide-water is comparatively short.

*Anthracite prices.*—The list prices of anthracite coal, prepared sizes, remained the same throughout the year, being $4.75 for lump and $5 for egg, stove, and chestnut, all f. o. b. New York Harbor. In April the usual discount of 50 cents per ton was made, prices being then $4.25 for lump and $4.50 for egg, stove, and chestnut. In May the discount was reduced to 40 cents; in June, to 30; in July, to 20; in August, to 10 cents, and on September 1 the fall list prices were again in force. This discount is made to promote buying of stocks in summer. Last year it did not work to the same extent as in some previous years.

The price of the small or steam sizes at the opening was as follows: Pea, $3; buckwheat, $2.25; buckwheat No. 2, or rice, $1.60; buckwheat No. 3, or barley, $1.40. The large demand for these sizes increased prices of the smaller coals, and in June quotations were: Pea, $3; buckwheat, $2.50; rice, $1.85; barley, $1.50. In September a general advance of 25 cents was made, and prices to the end of the year were: Pea, $3.25; buckwheat, $2.75; rice, $2.25; barley, $1.75; all f. o. b. New York Harbor. As the demand continued large and supplies were not abundant, from 15 to 25 cents per ton was added to these prices on smaller orders toward the close of the year.

*The bituminous market.*—The bituminous market in New York territory was not marked by any of the sharp competition or cutting which were features of some previous years. Both the Clearfield and West Virginia shippers secured a fair share of the trade, and prices were not reduced in any undue degree, at least in the ten prosperous months of the year. The Cumberland shippers have their own special market, which is not much disturbed by competition in ordinary times.

January opened with a good supply of coal at the seaboard and also a large demand for steam coal. The only difficulty in the trade was the short car supply, about which many complaints were heard. Transportation from the mines was slow also, cars taking ten days or more to come through. This was generally due to insufficient motive power, as the railroads were generally free from snow and other winter obstructions, though they were congested with a very heavy traffic in general freight. In February conditions were made still worse by heavy storms and delays on the railroads resulting from them. When these conditions were removed, delays from car shortage still continued, as has been already referred to.

Most of the yearly contracts for bituminous coal are made in March. There was some delay last year, as the railroads did not announce the freight rates for the season until later than usual. When this was done, the rates were found to be from 5 to 10 cents higher than those for the previous year. This had little effect on the contract business, but it was found that an unusual number of large consumers believed it more to their advantage to take the chances of the open market.

Business in steam coal continued good until late in the year, and the distribution of coal in New York territory was large. A decrease in demand made itself felt toward the end of November, though the financial conditions were slower in disturbing the coal trade than might have been expected. December was a dull month, not so much in New York City trade as in the outside territory and especially along Long Island Sound, where the many manufacturing towns were seriously affected. The year closed with a quiet market and some apprehensions for the future.

The bunker trade—that is, the supply of coal for steamships—was generally good through the year, and absorbed a large quantity of coal. The export trade was fair, though comparatively little of this is done in New York, foreign shipments going chiefly from Baltimore, Md., and Newport News and Lamberts Point, Va.

*Bituminous coal prices.*—In January the price of good grades of Clearfield and West Virginia bituminous coal was about $2.85 per ton f. o. b. New York Harbor ports, while inferior grades could be had for 10 or 15 cents less. During the month prices softened a little, and by February 1 the average quotation was $2.70 to $2.75; by the middle of the month $2.60 to $2.70 was the range. In March the embargo placed on coal traffic by several of the railroads stiffened prices, and $2.80 to $2.85 was named for New York Harbor ports. This continued for a month or so, but when the spring contracting was well over prices settled, and through May $2.50 to $2.60 was the general quotation. Through June and July there were small fluctuations, but generally a higher range, $2.60 and $2.75 being the outside figures. In August there was a rush on the part of buyers from New England ports where the harbors are icebound in the winter, which ran up prices to $2.75 to $2.80, as high as $3 being paid in some cases. In September car shortage and slow transportation were felt; supplies were short and prices advanced to $3, then to $3.25; in one case $3.55 was paid for a large lot of Georges Creek coal. These high figures continued through October.

The coal market in bituminous, as in anthracite business, was rather slow to feel the commotion in the stock market. Prices began to decline when the demand for coastwise shipments to the ice-making ports ceased. By the latter part of November they had settled down to $2.65 to $2.75 again. Then manufacturers began to realize the fall in business; the demand for steam coal decreased sharply and there was a surplus instead of a shortage in supplies. The price fell to $2.50, New York Harbor, and would have gone lower had it not been for the action of some large producers in curtailing production and holding back shipments.

The prices given above are the average for good grades of Clearfield coal, which are taken as a basis. Some special coals will sell for 15 to 25 cents higher, while off grades may be had for 10 or 15 cents lower.

*The coastwise trade.*—The coastwise trade from New York has two chief divisions, along Long Island Sound and to the far eastern ports, chiefly in Maine. The Sound trade is an all-the-year-round business, while that to the far east is necessarily done in summer, as the ports are mostly closed by ice in the winter.

The supply of vessels in the spring was fair and rates were not high. It was not long before the smaller vessels in the Sound trade began to make serious complaints about delays in unloading. This was partly due to the restricted dock capacity and partly to the delays of the railroads in carrying away coal from the docks. Quite early in the season vessel owners began to insist on the "loading and discharging clause," providing penalties for delays in port. This was generally the rule through the season. Vessel rates continued to advance. In September and October, when there was a rush to get coal to the shoal water or ice-making ports before they were closed by winter, charters were made at almost any figure the boat owner might ask. This did not last long, however, and before the end of the year chartering was almost stopped and rates were accordingly low.

The contest between the sailing vessels and the barges in the coal-carrying trade became more acute during the year. The loss of several barges, which broke loose from their tows, and the danger to other vessels from the long tows in use, have been the causes for a general investigation of the system. It is not impossible that there will be some legislation to limit the length of tows, to provide some safeguards, and otherwise to regulate the barge system. There is little question that in many cases safety has been disregarded in order to reduce expenses and that some restrictions are needed.

### BOSTON, MASS.

Mr. Daniel D. Morss, secretary of the Boston Chamber of Commerce, has furnished the following statistics relating to the receipts and shipments of coal and coke at Boston during 1907. The total movement in 1907 was the largest in the history of the city. The receipts amounted to 5,884,924 long tons, against 5,177,595 long tons in 1906.

The year of largest previous receipts of coal at the port of Boston was 1903, which followed the great strike in the anthracite region of Pennsylvania. The receipts in 1903 amounted to 5,663,940 long tons, which was an increase of nearly 1,400,000 tons over the preceding year, when the tonnage was curtailed by the anthracite strike. The receipts of anthracite at Boston in 1903 were 2,042,512 long tons, which exceeded the receipts of anthracite in 1907 by 98,157 tons. A part of the shortage in 1903 was also made up by receipts of foreign coal, which amounted to nearly 1,450,000 tons, whereas the receipts of foreign coal in 1907 were only 545,652 tons. The receipts of domestic bituminous coal, however, exceeded in 1907 the record for 1903 by 1,022,155 long tons.

The following table shows the receipts of both anthracite and bituminous coal, by months, in 1907, and the totals for 1907 are compared with those of the three preceding years:

*Monthly receipts of coal at Boston, Mass., for 1907, with comparisons, in long tons.*

| Month. | Receipts. | | Quantity forwarded to New England points. | | Net receipts (for local consumption). | |
|---|---|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| January | 172,843 | 252,985 | 32,035 | 52,628 | 140,808 | 200,357 |
| February | 100,148 | 197,541 | 31,866 | 51,128 | 68,282 | 146,413 |
| March | 203,585 | 330,187 | 33,626 | 65,798 | 169,959 | 264,389 |
| April | 185,621 | 317,461 | 22,986 | 68,872 | 162,635 | 248,589 |
| May | 193,665 | 355,491 | 17,695 | 86,302 | 175,970 | 269,189 |
| June | 171,810 | 337,217 | 13,417 | 45,329 | 158,393 | 291,888 |
| July | 209,736 | 312,153 | 27,041 | 59,085 | 182,695 | 253,068 |
| August | 163,834 | 442,734 | 22,872 | 66,359 | 140,962 | 376,375 |
| September | 133,727 | 304,029 | 18,640 | 80,720 | 115,087 | 223,309 |
| October | 170,526 | 284,628 | 25,905 | 77,702 | 144,621 | 206,926 |
| November | 169,119 | 355,594 | 23,096 | 82,488 | 146,033 | 273,106 |
| December | 178,674 | 341,616 | 12,464 | 117,936 | 166,210 | 223,680 |
| Total, 1907 | 2,053,288 | 3,831,636 | 281,633 | 854,347 | 1,771,655 | 2,977,289 |
| 1906 | 1,659,679 | 3,517,916 | 197,690 | 1,370,477 | 1,461,989 | 2,147,439 |
| 1905 | 1,977,398 | 3,406,761 | 254,565 | 1,093,879 | 1,722,833 | 2,312,882 |
| 1904 | 2,002,779 | 3,065,873 | 269,105 | 1,094,665 | 1,733,674 | 1,971,208 |

The following table shows the receipts of domestic and foreign coal at the port of Boston for a series of five years. The receipts of foreign coal are almost entirely those covering Nova Scotian bituminous coal delivered to the by-product coke oven plant at Everett, Mass.:

*Receipts of coal at Boston, Mass., for five years, in long tons.*

| Year. | Domestic. |  |  |  | Foreign. |  | Total. |
|---|---|---|---|---|---|---|---|
|  | By water. |  | By rail. |  |  |  |  |
|  | Anthracite. | Bituminous. | Anthracite. | Bituminous. | Anthracite. | Bituminous. |  |
| 1903 | 2,042,512 | 2,078,499 | 109,033 | 185,330 | 22,432 | 1,220,134 | 5,663,940 |
| 1904 | 1,961,785 | 2,397,885 | 40,994 | 117,605 | ............ | 550,383 | 5,068,652 |
| 1905 | 1,941,478 | 2,757,186 | 35,920 | 41,104 | ............ | 608,471 | 5,384,159 |
| 1906 | 1,630,674 | 2,772,593 | 29,005 | 87,251 | ............ | 658,072 | 5,177,595 |
| 1907 | 2,016,252 | 3,196,057 | 37,036 | 89,927 | ............ | 545,652 | 5,884,924 |

Coastwise coal freights in 1907 were somewhat higher than in either 1906 or 1905. The minimum rate from New York was from 50 to 55 cents per ton in 1907, against 50 cents in 1906, although the maximum rate was 5 cents less in 1907 than in 1906. The minimum rate from Philadelphia was 5 cents more, and the maximum rate 30 cents more in 1907 than in 1906. Equivalent higher rates were obtained from Baltimore and Norfolk or Newport News.

The following tables show the minimum and maximum freights quoted from Boston during 1906 and 1907:

*Coal freights to Boston during 1906.*

| From— | Minimum. |  | Maximum. |  |
|---|---|---|---|---|
|  | Rate. | Date. | Rate. | Date. |
| New York | $0.50 | July 1-July 15 | $0.90 | December 15. |
| Philadelphia | .60 | July 1-August 31 | 1.05 | November 24. |
| Baltimore | .65 | July 3 | 1.15 | November 30. |
| Norfolk and Newport News | .65 | August 15 | 1.10 | December 10. |

*Coal freights to Boston during 1907.*

| From— | Minimum. |  | Maximum. |  |
|---|---|---|---|---|
|  | Rate. | Date. | Rate. | Date. |
| New York | [a] $0.50-$0.55 | ............ | $0.85 | March 30. |
| Philadelphia | .65 | December 10 | 1.35 | March 25-April 1. |
| Baltimore | .75 | December 20 | 1.30 | March 15-April 1. |
| Norfolk and Newport News | .75 | December 9 | 1.25 | March 18. |

[a] 50 to 55 cents is season rate on coal-carrying railroad transportation. 60 cents was the minimum rate on rail tonnage from New York to Boston.

## PHILADELPHIA, PA.

The following review of the coal trade of Philadelphia has been prepared for this report by Mr. Samuel R. Kirkpatrick:

The mining of anthracite and bituminous coal in Pennsylvania was almost entirely free from trouble between the miners and operators during the year 1907. There were some petty annoyances, but nothing occurred to prevent the greatest output of anthracite in the history of hard-coal mining. The total shipments from the anthracite mines during the year amounted to 67,109,398 long tons, exclusive of the coal used at the mines and in their vicinity, which brought the production up to nearly 75,000,000 long tons. To produce such an immense tonnage, over 5,000,000 tons a month had to be mined. During but one month of the year (February) did the output fall below 5,000,000 tons, when it dropped to 4,563,720 tons. In October 6,015,851 tons were shipped, this being the greatest movement of anthracite in any one month since its introduction as a fuel. From the beginning of the year the demand for hard coal assumed large proportions. The fear of labor troubles at the mines caused many a householder to lay in his winter supply. Although the amount of anthracite sold previous to January 1, 1907, was large, the cold weather soon depleted small stocks and there was an urgent demand for all of the domestic sizes. Years must elapse before the strike of 1902 is forgotten, and consequently the operator and dealer look forward to doing a big business during the months when the annual reduction from the list or circular prices is made. The year 1907 was a record breaker in every respect. Owing to the great demand not only for domestic use, but also for manufacturing purposes, the consumption of coal was greater than ever before. None of the important producing companies was able to accumulate any extra stock until about the last month of the year. At that time business throughout the country suffered a reaction, and in many instances industrial plants were retrenching. The demand for anthracite was maintained, however, until after the close of the year. Owing to the increased shipping facilities, the railroads were able to handle a much larger tonnage than in any previous year. Until recently it has been almost impossible to mine 5,000,000 tons during two consecutive months, while in 1907 there were eleven months in which that figure was exceeded.

While at the beginning of the year there were large amounts of coal in the bins of the consumers, this supply was greatly lessened before April 1, and with the annual spring reduction of 50 cents a ton, the demand was greater than could be met. Many of the orders that were placed in April were not filled until the following months, and then at an advance of 10 cents a ton, each month, after April. The increase in the consumption of anthracite coal was not confined to Philadelphia. The shipments to the yards of the various producing companies in the West were much heavier than ever before, and for the first time for several years a good supply of anthracite was obtainable. Shipments of this fuel from the port of Philadelphia, for coastwise and harbor trade, were never so large as in 1907. Coal companies having barges for the carrying of anthracite were compelled to charter extra vessels. Some of the manufacturing plants of Philadelphia which for a time employed bituminous coal, resumed the use of anthracite.

In accordance with the custom of past years, on April 1 the anthracite coal companies made a reduction of 50 cents a ton, advancing the price 10 cents each month until the 50 cents should be restored. It had been intimated that there would be no change in the circular prices, but such pressure was brought to bear that the customary reduction was made. Consumers who were caught napping in 1906 were among the first to make application for coal in April. There were so many orders, and for such large amounts, that the companies were compelled to prorate them. This caused some dissatisfaction among the dealers, but regardless of the many objections offered, the coal companies continued to ship as they saw fit until the latter part of July, as by that time not only was the trade supplied but the consumers as well had been protected. At no time during the year did the producing companies advance prices beyond the 10 cents each month after April. Toward the latter part of 1907, however, a number of retail dealers advanced the price of prepared sizes from 25 to 75 cents a ton.

The following table shows the range of retail prices of anthracite and bituminous coal during 1907, by months:

*Retail prices of anthracite and bituminous coal at Philadelphia during 1907, by months.*

| Month. | Prepared sizes. | Pea. | Buckwheat. | Rice. | Bituminous. |
|---|---|---|---|---|---|
| January | $6.75 | $4.50 | $3.00-$3.25 | $2.75 | $3.75-$4.00 |
| February | 6.75 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| March | 6.75 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| April | 6.25 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| May | 6.35 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| June | 6.45 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| July | 6.55 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| August | 6.75 | 4.50 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| September | 7.00 | 4.75 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| October | 7.00 | 4.75 | 3.00- 3.25 | 2.75 | 3.75- 4.00 |
| November | 7.00 | 4.75 | 3.00- 3.25 | 2.75 | 3.50- 3.75 |
| December | 7.00 | 4.75-5.00 | 3.50 | 3.00 | 3.50- 3.75 |

The production of anthracite coal during 1907 was uninterrupted, each company mining its full quota. The following table shows the shipments during each month of 1907 as compared with 1906:

*Anthracite tonnage for the year 1906-7, by months, in long tons.*

| Month. | 1906. | 1907. | Month. | 1906. | 1907. |
|---|---|---|---|---|---|
| January | 5,458,084 | 5,249,946 | August | 5,400,511 | 5,716,252 |
| February | 4,712,099 | 4,563,720 | September | 4,527,886 | 5,442,334 |
| March | 5,797,167 | 5,235,814 | October | 5,384,768 | 6,015,851 |
| April | [a] 488,203 | 5,916,583 | November | 5,182,153 | 5,666,205 |
| May | [a] 3,254,230 | 5,994,272 | December | 4,836,028 | 5,343,477 |
| June | 5,676,018 | 5,924,260 | | | |
| July | 4,981,448 | 5,602,435 | Total | 55,698,595 | 67,109,393 |

[a] Suspension.

In the latter part of September the retail operators advanced the price of egg, stove, and chestnut sizes 25 cents a ton, claiming insufficient profit at lower prices, but as many consumers had contracted for these sizes at the usual price—$6.75 a ton in the cellar—the advance was not general, and in many cases secret cutting was indulged in.

The domestic use of pea coal is becoming more general. The burning of this size being better understood, about 95 per cent of the production is now used by housekeepers. A few years ago pea coal was used by manufacturing companies almost exclusively. It now commands a better price, and before long will no doubt be classed with the other prepared sizes.

There was a great demand in 1907 for bituminous coal. The coastwise and harbor shipments of soft coal exceeded by 1,487,992 tons those of 1906, the total shipments last year amounting to 5,124,579 tons. All the coal-carrying companies showed a large increase in their shipments of soft coal. The piers for handling it have been enlarged and modernized, and many additional cargoes have been fitted out. The Government has taken a large supply, and great quantities of bituminous coal were sent from Philadelphia to New England and other parts of the United States. Owing to the exceptional demand, the price of bituminous coal was at times higher than it had been for years. The manufacutrers had difficulty in securing their full quota, as the railroads were unable to supply the necessary coal cars. In some instances the operators brought suit against the railroads, charging them with discrimination in furnishing cars. These suits are still pending.

The prices of the smaller sizes of anthracite coal at the mines during each month of 1907, as compared with the same time in 1906, are shown in the following table:

*Prices per long ton for smaller sizes of anthracite at mines, 1906-7, by months.*

| Month. | 1906. | | | 1907. | |
|---|---|---|---|---|---|
| | Pea. | Buckwheat. | Rice. | Pea. | Buckwheat. |
| January | $1.60-$1.75 | $0.90-$1.25 | $0.45-$0.75 | $1.65-$1.85 | $1.10-$1.25 |
| February | 1.50- 1.75 | .90- 1.25 | .45- .75 | 1.75- 1.85 | 1.10- 1.25 |
| March | 1.50- 2.35 | 1.00- 1.50 | .45- 1.25 | 1.75- 1.85 | 1.10- 1.25 |
| April[a] | (Strike.) | (Strike.) | (Strike.) | 1.75 | 1.10- 1.25 |
| May | 1.50- 1.75 | .90- 1.25 | .50- .65 | 1.65- 1.75 | 1.10- 1.25 |
| June | 1.35- 1.75 | .90- 1.25 | .40- .65 | 1.65- 1.75 | 1.10- 1.25 |
| July | 1.25- 1.75 | .90- 1.25 | .45- .65 | 1.65- 1.75 | 1.10- 1.25 |
| August | 1.25- 1.75 | .75- 1.25 | .40- .65 | 1.65- 1.75 | 1.10- 1.25 |
| September | 1.25- 1.75 | .75- 1.25 | .40- .65 | 1.75- 2.00 | 1.25- 1.50 |
| October | 1.35- 1.75 | .90- 1.25 | .40- .65 | 2.00- 2.25 | 1.25- 1.50 |
| November | 1.50- 1.75 | .90- 1.25 | .50- .75 | 2.00- 2.25 | 1.25- 1.50 |
| December | 1.75- 2.00 | .90- 1.25 | .50- .75 | 2.00- 2.25 | 1.25- 1.50 |

[a] During April, 1906, the mines were shut down, and very little coal was used. Individual operators received as much as $3 a ton for pea, $2 for buckwheat, and $1.50 for rice.

There was an increase in the exports of both anthracite and bituminous coal from the port of Philadelphia in 1907 as compared with 1906. The shipments of hard coal to points outside of the United States amounted to 48,541 tons, as compared with 39,098 tons in 1906 and 40,414 tons in 1905. The largest quantity of hard coal exported from Philadelphia in 1907 (25,708 tons) was sent to Cuba. Canada received 13,966 tons, while 934 tons were sent to Mexico. Newfoundland took 6,494 tons; Haiti, 381 tons; Bermuda, 998 tons, and the British West Indies, 60 tons. The anthracite exported was valued at $200,286.

The export shipments of bituminous coal in 1907 showed an increase of 176,026 tons over those of 1906, the total shipments amounting to 879,177 tons. As has been the case for several years, Cuba took the largest amount, 411,410 tons of soft coal being sent there. Mexico received 213,117 tons, as against 190,437 tons in 1906. Canada and Newfoundland took 36,349 tons; Guatemala, 11,125 tons; Panama, 37,848 tons; the French West Indies, 49,918 tons, and the Danish West Indies, 25,763 tons. Italy received 22,708 tons, and 22,745 tons were sent to the British West Indies. The Philippine Islands received 17,957 tons, and 2,798 tons were shipped to Austria-Hungary. Santo Domingo, Brazil, Chile, and Peru received over 5,000 tons each. The total value of bituminous coal exported from Philadelphia in 1907 was $2,433,051, as against $1,647,119 in 1906.

There was no change in freight rates for local delivery during the year. The charges per ton, which vary according to the region from which the shipment is made and according to size of coal, were as follows:

*Freight rates per long ton on anthracite from coal regions to Philadelphia, Pa.*

| Region. | Prepared sizes. | Pea. | Buckwheat. |
|---|---|---|---|
| Schuylkill | $1.70 | $1.40 | $1.25 |
| Lehigh | 1.75 | 1.45 | 1.30 |
| Wyoming | 1.80 | 1.50 | 1.35 |

Through the courtesy of the officers of the Pennsylvania Railroad Company, the Philadelphia and Reading Railway Company, the Lehigh Coal and Navigation Company, and the Baltimore and Ohio Railroad Company, data have been furnished from which the following table has been compiled. It shows the distribution of coal at Philadelphia for the export trade, the coastwise and harbor trade, and the Philadelphia local trade.

*Distribution of coal at Philadelphia, Pa., in 1906 and 1907, in long tons.*

| Destination. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| Export | 39,098 | 603,151 | 48,541 | 879,177 |
| Coastwise and harbor | 1,583,086 | 3,636,587 | 2,173,901 | 5,124,579 |
| Local | 3,999,953 | 2,327,019 | 4,742,062 | 2,208,712 |
| Total | 5,622,137 | 6,566,757 | 6,964,504 | 8,212,468 |

The price circular of the Philadelphia and Reading Coal and Iron Company, which is the same as that of other companies, is as follows:

*Circular prices for anthracite coal in Philadelphia, Pa., in 1905, 1906, and 1907.*

| Size. | 1905. | | 1906. | | 1907. | | |
|---|---|---|---|---|---|---|---|
| | April. | September. | April. | September. | January. | April. | September. |
| Lump | $3.00 | $3.00 | $3.00 | $3.00 | $3.50 | $3.25 | $3.50 |
| Steamboat | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Broken | 3.00 | 3.50 | 3.50 | 3.50 | 3.50 | 3.00 | 3.50 |
| Egg | 3.25 | 3.75 | 3.75 | 3.75 | 3.75 | 3.25 | 3.75 |
| Stove | 3.25 | 3.75 | 3.75 | 3.75 | 3.75 | 3.25 | 3.75 |
| Chestnut | 3.25 | 3.75 | 3.75 | 3.75 | 3.75 | 3.25 | 3.75 |
| Pea | 1.50 | 1.50 | 3.00 | 1.75 | 1.75 | 1.75 | 2.00 |
| Buckwheat | 1.00 | 1.00 | 2.00 | 1.25 | 1.25 | 1.25 | 1.50 |

## BALTIMORE, MD.

The following review of the coal trade of Baltimore, Md., for 1907, has been prepared for this report by Mr. Maurice J. Lunn, editor of Coal and Coke:

In general with other sections, the coal trade of Baltimore in 1907 was quite satisfactory as a whole, the tonnage being larger than the previous year, the transportation problem being comparatively easy, and fair prices maintaining well up to the close of the year.

In the anthracite trade there was nothing worthy of special comment, the trade taking its usual course from month to month, although the extension of unusually cold weather into the late spring made this branch of the coal business somewhat more active than customary for that season. The anthracite production last year was exceptionally large, and Baltimore naturally took its pro rata share of this increased tonnage.

The bituminous coal trade of Baltimore was quite satisfactory for the year, although it encountered a setback during the last two months of the year, due to the general depression in business which began in the fall throughout the country. The depression of the last month or two of the year, however, was not sufficient to materially affect the total of the year's coal business. The receipts were larger, and the coastwise shipments and domestic exports of coal from this port show gains over the figures of the previous year, as will be seen from the tables herein given.

*Coastwise coal shipments from Baltimore, Md., 1903–1907, in long tons.*

| Year. | Anthracite. | Bituminous. | Total. |
|---|---:|---:|---:|
| 1903 | ........ | ........ | 1,731,896 |
| 1904 | 238,728 | 2,064,060 | 2,302,788 |
| 1905 | 252,568 | 2,832,321 | 3,084,889 |
| 1906 | 238,162 | 3,176,710 | 3,414,872 |
| 1907 | 266,062 | 3,804,066 | 4,070,128 |

The domestic exports of bituminous coal from the port of Baltimore continue to show considerable increase each year over the preceding period, there being a growing market for coal from Baltimore both in Cuba and in Mexico. The following table gives these exports by months for 1907 and the totals for the previous four years:

*Domestic exports of bituminous coal and coke from Baltimore, Md., 1907, in long tons.*

| Month. | Coal. | Coke. | Month. | Coal. | Coke. |
|---|---:|---:|---|---:|---:|
| January | 44,652 | 4,867 | August | 50,502 | 1,544 |
| February | 41,372 | 6,265 | September | 36,737 | 10,437 |
| March | 35,348 | 9,430 | October | 37,276 | 3,548 |
| April | 45,810 | 6,318 | November | 73,926 | 7,553 |
| May | 50,392 | 5,595 | December | 61,990 | 6,398 |
| June | 31,516 | 11,225 | | | |
| July | 50,359 | 4,642 | Total | 559,880 | 77,822 |

The total exports of coal from Baltimore in 1906 were 458,203 tons; in 1905, 341,107 tons; in 1904, 150,912 tons, and in 1903 they were 116,294 tons, showing an increase of 100,000 tons in 1906 and in 1907, as compared with the preceding years.

The following table gives the receipts and shipments of anthracite and bituminous coal at Baltimore, Md., in 1906 and 1907:

*Receipts and shipments of coal at Baltimore, Md., during the years 1906 and 1907, in long tons.*

| | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Receipts. | Tidewater shipments. | | Receipts. | Tidewater shipments. | |
| | | Coastwise. | Exports. | | Coastwise. | Exports. |
| Bituminous | 4,208,800 | 3,176,710 | 458,203 | 5,154,526 | 3,804,066 | 559,880 |
| Anthracite | 707,425 | 238,162 | .......... | 803,031 | 266,062 | .......... |
| Total | 4,916,225 | 3,414,872 | 458,203 | 5,957,557 | 4,070,128 | 559,880 |
| Coke | .......... | .......... | .......... | [a] 226,185 | .......... | .......... |

[a] Short tons.

It will be seen from the above that the receipts of coal at Baltimore in 1907 increased 1,041,332 long tons, as compared with the previous year, while the coastwise shipments increased 655,256 tons, and the exports increased 101,677 tons, as compared with the year 1906.

In compiling the coal tonnage of the port of Baltimore, the receipts of coal at the plants of the Maryland Steel Company at Sparrows Point, Md., about 9 miles from the city, and of the Central Foundry Company, located at Dundalk, about 6 miles out of the city. These figures, which are not included in the table above, are as follows:

Mr. R. K. Wood, general agent of the Maryland Steel Company, states that the consumption of bituminous coal for all purposes during 1907 amounted to 517,139 long tons, as against 615,333 long tons in 1906, and that the works consumed 182,928 long tons of coke during the year, purchased from outside sources, in addition to the coke manufactured in its own ovens at the plant, which compares with 117,154 long tons of coke from the same source in the previous year.

Mr. D. Keller, manager of the Central Foundry Company, states that 2,755 long tons of coal and 3,773 short tons of coke were consumed at this plant during the past year, as compared with 2,560 long tons of coal and 4,183 short tons of coke in 1906.

## PITTSBURG, PA.

In the following tables is presented a statement showing the quantity of coal received at and in the vicinity of Pittsburg, by both rail and water, and the shipments of coal through and from the Pittsburg district to the west during the last five years. This statement has been compiled from reports made to the Geological Survey by officials of the railroads entering Pittsburg and by the United States army officer in charge of the slack-water navigation on the Monongahela River and at Davis Island dam on the Ohio River below Pittsburg. The railroad officials furnishing the information in the report to whom special acknowledgment is due are Messrs. J. G. Searles, general coal freight agent of the Pennsylvania Railroad at Philadelphia; W. L. Cromlish, coal and coke agent of the Baltimore and Ohio Railroad at Pittsburg; C. F. Perkins, general ore and coal agent of the Pennsylvania lines west of Pittsburg, at Pittsburg; W. A. Terry, general freight agent of the Pittsburg and Lake Erie Railroad at Pittsburg;

J. B. Safford, superintendent of the Pittsburg, Chartiers and Youghiogheny Railroad at Pittsburg, and H. J. Booth, general freight agent of the Wheeling and Lake Erie Railroad (Wabash) at Pittsburg. The statistics of the movement of coal through the Monongahela River locks and at the Davis Island dam have been furnished by Maj. H. C. Newcomer, Corps of Engineers, U. S. Army.

These tables show that while the river shipments to and through Pittsburg in 1907 exceeded those of 1906 by 1,091,028 short tons, shipments by rail decreased by 1,934,669 short tons, and the total movements to Pittsburg and to western points in 1907 were 843,641 short tons less than in 1906. To offset this decrease, however, there was a considerable increase in shipments of coal from mines in the Pittsburg district to eastern points. In 1906 the quantity of coal shipped east from the Pittsburg district was approximately 10,000,000 short tons, while in 1907 this business amounted to 12,202,530 tons, an increase over the preceding year of about 2,200,000 short tons, and the total movement of coal for the Pittsburg district in 1907 was accordingly about 1,350,000 tons over that of 1906.

As shown in the following tables the decrease in 1907 was principally in the rail shipments from the Pittsburg district to western points. The rail shipments to Pittsburg and vicinity decreased from 5,107,413 short tons in 1906 to 4,774,977 short tons in 1907, while the rail shipments to points west of Pittsburg decreased from 22,419,496 short tons to 20,817,263 tons. The water shipments, on the other hand, showed increases both in coal sent to Pittsburg and in that sent to western and southwestern points. The river shipments to Pittsburg and vicinity increased from 6,840,816 short tons in 1906 to 7,611,680 tons in 1907, while the shipments through Davis Island dam increased from 2,883,965 short tons to 3,204,129 short tons. The total shipments by rail and water to Pittsburg and through Pittsburg to western points in 1907 were 36,408,049 short tons, against 37,251,690 tons in 1906. The total river shipments increased from 9,724,781 tons in 1906 to 10,815,809 tons in 1907, while the total rail shipments decreased from 27,526,909 tons to 25,592,240 tons.

The rail and water shipments to Pittsburg and vicinity and through Pittsburg to western points during the last five years have been as follows:

*Movement of coal to and through Pittsburg, 1903–1907, in short tons, showing totals by rail and water.*

| | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| By rail: | | | | | |
| To Pittsburg district | 5,160,275 | 5,083,535 | 5,463,012 | 5,107,413 | 4,774,977 |
| To west of Pittsburg | 15,965,442 | 16,017,327 | 18,370,368 | 22,419,496 | 20,817,263 |
| Total by rail | 21,125,717 | 21.100,862 | 23,833,380 | 27,526,909 | 25,592.240 |
| By Monongahela River locks:[a] | | | | | |
| To Pittsburg district | 6,303.365 | 4.173,992 | 5,558.541 | 6,840,816 | 7,611,680 |
| To west of Pittsburg | 3,069,299 | 2.811,584 | 3,926,319 | 2.883,965 | 3.204,129 |
| Total by water | 9,372,664 | 6,985,576 | 9,484,860 | 9,724,781 | 10,815.809 |
| Total shipments | 30,498,381 | 28,086,438 | 33,318,240 | 37,251,690 | 36,408,049 |

[a] The coal traffic on the Monongahela is obtained by adding to that which passes Lock No. 3 the coal mined and shipped in pools Nos. 1 and 2. In 1907 there were consumed in pools Nos. 1 and 2 5,837,209 tons river coal, and in the harbor below No. 1, including the lower Allegheny River, 1,774,471 tons of Monongahela River coal, a total of 7,611,680 tons locally consumed.

*Movement of coal to and through Pittsburg, 1903–1907, in short tons, showing totals to Pittsburg district and west of Pittsburg.*

| | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| To Pittsburg district: | | | | | |
| By rail | 5,160,275 | 5,083,535 | 5,463,012 | 5,107,413 | 4,774,977 |
| By water | 6,303,365 | 4,173,992 | 5,558,541 | 6,840,816 | 7,611,680 |
| Total to Pittsburg district | 11,463,640 | 9,257,527 | 11,021,553 | 11,948,229 | 12,386,657 |
| To west of Pittsburg: | | | | | |
| By rail | 15,965,442 | 16,017,327 | 18,370,368 | 22,419,496 | 20,817,263 |
| By water | 3,069,299 | 2,811,584 | 3,926,319 | 2,883,965 | 3,204,129 |
| Total to west of Pittsburg | 19,034,741 | 18,828,911 | 22,296,687 | 25,303,461 | 24,021,392 |
| Total shipments | 30,498,381 | 28,086,438 | 33,318,240 | 37,251,690 | 36,408,049 |

## CLEVELAND, OHIO.

The total receipts of coal and coke in Cleveland, as reported by Mr. Munson A. Havens, secretary of the chamber of commerce, amounted in 1907 to 6,998,124 short tons, an increase over 1906 of 171,037 short tons. This increase would have been much larger except for the effects of the financial disturbance which were felt more immediately in the cities of the middle west than in New York, Boston, Philadelphia, or Baltimore. There was a slight falling off in the receipts of bituminous coal, and gains in the receipts of anthracite and of coke were recorded. The shipments of coal and coke from Cleveland in 1907 amounted to 3,441,666 short tons, compared with 3,099,822 short tons in 1906. The difference between the receipts of 6,998,124 short tons and the shipments of 3,441,666 short tons represents the local consumption of 3,556,458 short tons, a decrease, compared with 1906, of about 170,000 tons.

The following tables show the quantities of bituminous and anthracite coal and of coke received and shipped and the local consumption at Cleveland during the last five years:

*Coal and coke receipts and shipments at Cleveland, Ohio, 1903–1907, in short tons.*

RECEIPTS.

| Kind. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Bituminous | 5,577,964 | 5,347,476 | 4,846,162 | 6,021,958 | 5,995,197 |
| Anthracite | 254,193 | 199,907 | 295,423 | 145,822 | 153,077 |
| Coke | 763,430 | 594,101 | 583,053 | 659,307 | 849,850 |
| Total | 6,595,587 | 6,141,484 | 5,724,638 | 6,827,087 | 6,998,124 |

SHIPMENTS.

| | | | | | |
|---|---|---|---|---|---|
| Anthracite by rail | 6,590 | 27 | 74 | 10,138 | 7,553 |
| Bituminous by rail | 62,082 | 61,047 | 50,575 | 45,687 | 112,500 |
| Bituminous by lake | 2,752,549 | 3,052,819 | 2,567,916 | 2,926,279 | 3,264,875 |
| Coke by rail | 18,170 | 21,655 | 45,527 | 117,718 | 56,738 |
| Total | 2,839,391 | 3,135,548 | 2,664,092 | 3,099,822 | 3,441,666 |

*Total coal receipts and shipments, with local consumption, at Cleveland, Ohio, 1903–1907, in short tons.*

| Year. | Receipts. | Shipments. | Local consumption. |
|---|---|---|---|
| 1903 | 6,595,587 | 2,839,391 | 3,756,196 |
| 1904 | 6,141,484 | 3,135,548 | 3,005,936 |
| 1905 | 5,724,638 | 2,664,092 | 3,060,546 |
| 1906 | 6,827,087 | 3,099,822 | 3,727,265 |
| 1907 | 6,998,124 | 3.441,666 | 3,556,458 |

## CHICAGO, ILL.

Because of the fact that one of the transportation companies declined to furnish the Chicago bureau of coal statistics the figures of the coal shipments over its line in 1907 that bureau was unable to compile its usual statement on the coal trade of Chicago for last year, and the statistics are therefore not available for this report.

## CINCINNATI.

Mr. Chas. B. Murray, superintendent of the chamber of commerce of Cincinnati, has furnished the following extract from his annual report in advance of its publication.

The aggregate receipts of coal at Cincinnati in 1907 fell considerably short of the exceptional quantity reported for the preceding year. The decrease was in arrivals by railroad, which were of less volume than for either of the two years next preceding. The total by river was about 14 per cent in excess of the preceding year, and about 12 per cent in excess of the annual average of receipts by river during five years prior to 1907. The railroad receipts, while about 27 per cent below the preceding year, were 12 per cent greater than the annual average for the period of five years.

The receipts of coal in 1907 by river were 64,647,000 bushels, compared with 56,739,000 for 1906, and an annual average of 57,791,000 for five years prior to 1907. Of these receipts for the last year about 47 per cent represented product from the Pittsburg district, 52 per cent from the Kanawha district, and 1 per cent from other localities.

Receipts of coal by railroad in 1907 were 85,333,000 bushels, compared with 117,218,000 for 1906, and an annual average of 76,192,000 for five years. It is estimated that about 55 per cent of the arrivals by railroad represented product from the Kanawha district, and 45 per cent from other sources, mainly in Ohio.

The total receipts of coal at Cincinnati in 1907 were 149,980,000 bushels, compared with 173,957,000 for 1906, and an annual average of 133,983,000 for five years. Of the total from all sources the past year about 20 per cent came from the Pittsburg district, 53 per cent from the Kanawha district, and 27 per cent from other sections, mainly in Ohio.

Shipments of coal from Cincinnati in 1907 represented a total of 71,414,000 bushels, of which 5,006,000 bushels were by river and 66,408,000 by railroad, the latter including an unknown quantity appearing in the reported arrivals, but destined to points beyond without reference to local interests. The total shipments in 1907 were 99,045,000 bushels, and the annual average for five years 56,751,000 bushels.

Prices of coal afloat in 1907 from the Pittsburg and Kanawha districts ranged at 8 to 9 cents per bushel, at Cincinnati, with an average of 8.20 cents for the year. For run-of-mine coal, the prevailing price was 7½ cents per bushel until November, then advanced to 7¾ cents; for nut and slack, 6 to 6½ cents per bushel. The price of lump coal for both Pittsburg (Youghiogheny) and Kanawha, delivered to consumers, was $3.25 per ton for about five months of the year, $3.50 for four months, and $3.75 for three months, making an average of $3.47 per ton, compared with $3.38 for 1906. On the bushel basis the average for 1907 was 12.45 cents, compared with 12.20 cents for 1906, and an annual average of 11.84 cents for five years prior to 1907, for deliveries to consumers. For nut and slack the range was mainly $2.10 to $2.25 per ton for deliveries to consumers.

Anthracite coal is but moderately consumed in this market, the total receipts in 1907 being 654,000 bushels, compared with 792,000 bushels for 1906, and an annual average of 578,000 bushels for five years prior to 1907. The price for lots delivered to consumers was $7.25 to $7.50 per ton, the lower rate for about four months of the period.

The local consumption of coal, as near as can be estimated upon statements of dealers, has been pretty evenly divided between industrial and household requirements, with a tendency of enlargement of the industrial proportion in late years, so that probably 55 per cent is not too high to estimate such consumption at this time.

For the year 1907 the local gas works consumed coal to the extent of 255,563 tons of 2,000 pounds, or 7,100,000 bushels. There were sent out from the works during the year 2,461,004,000 cubic feet of manufactured gas, and the product of electric current represented 40,950,000 kilowatts. Compared with the preceding year there was an increase of about 14¾ per cent in coal consumed, about the same quantity of manufactured gas sent out, and 15 per cent increase in product of electric current. There was additionally sent out 164,568,000 feet of natural gas.

The yearly range and average prices of Pittsburg coal, afloat and delivered, per bushel, based on weekly records, compared for a series of years, are shown in the following table:

*Prices of Pittsburg coal at Cincinnati, 1902–1907, in cents per bushel.*

| Year. | Afloat. | | | Delivered. | | |
|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. |
| 1902 | 6½ | 10 | 7.92 | 10 | 14½ | 11.75 |
| 1903 | 9 | 10 | 9.25 | 12⅝ | 14½ | 13.18 |
| 1904 | 8 | 9 | 8.50 | 10¼ | 13½ | 11.50 |
| 1905 | 8 | 8 | 8.00 | 11¼ | 12⅝ | 12.05 |
| 1906 | 7½ | 8½ | 7.80 | 11¼ | 12⅝ | 12.20 |
| 1907 | 8 | 9 | 8.20 | 11¼ | 14⅜ | 12.45 |

*Summary of coal movements at Cincinnati, Ohio, in 1906 and 1907, in bushels.*

| Details. | 1906. | 1907. | Details. | 1906. | 1907. |
|---|---|---|---|---|---|
| Total received | 173,957,000 | 149,980,000 | Anthracite | 792,000 | 654,000 |
| Pittsburg | 31,118,000 | 30,726,000 | Total: | | |
| Ohio River | 1,970,000 | 426,000 | By river | 56,739,000 | 64,647,000 |
| Kanawha: | | | By rail | 117,218,000 | 85,333,000 |
| By river | 23,651,000 | 33,495,000 | Shipped: | | |
| By rail | 64,034,000 | 46,573,000 | By river | 5,833,000 | 5,006,000 |
| Total Kanawha | 87,685,000 | 80,068,000 | By rail | 93,212,000 | 66,408,000 |
| Other kinds by rail | 52,392,000 | 38,106,000 | Total shipped | 99,045,000 | 71,414,000 |

Coal from Virginia and from the Kanawha and other West Virginia regions sells at the same, or about the same, prices as are obtained for the product in the Pittsburg district. Sales afloat are on the bushel basis—72 pounds. Sales delivered are on the basis of the short ton of 2,000 pounds and represent screen or lump coal. The receipts of coke for 1907 were 4,577,000 bushels, and the quantity locally manufactured amounted to 9,233,000 bushels, making a total of 13,810,000, as compared with 13,502,000 bushels in 1906. For city manufacture the average price for the year was 11½ cents per bushel. Gas-house coke was 9½ cents a bushel, and Connellsville coke sold at $6.60 per ton.

## MILWAUKEE, WIS.

The following review of the coal trade of Milwaukee has been furnished by Mr. W. J. Langson, secretary of the Chamber of Commerce:

The coal record of 1907 still further enhances the position of Milwaukee as the leading receiving, distributing, and consuming port on the upper lakes for the coals of Pennsylvania, Ohio, and Michigan. The receipts through all channels reached the unprecedented total of 4,349,507 short tons, an increase over total supply of 1906 of better than half a million tons. The receipts of the past year consisted of 4,039,512 tons by lake and 309,995 tons by rail and car ferries. The total shipments of the year were 1,310,862 tons, showing an increase of 122,420 tons, against an increase of 534,232 tons in the receipts. As the stocks of coal were quite low before the resumption of lake navigation, the above figures would indicate a larger increase in local consumption than in shipments. The lake receipts consisted of 858,402 tons of hard, and 3,181,110 tons of soft coal. There is no record of the kind of coal received by rail and car ferry, but with rare exceptions the rail receipts consist of soft coal and the car ferry receipts of the same variety.

Competition in the coal business having been practically eliminated, prices have continued at relatively high figures, especially for domestic purposes.

The manufacture of coke at Milwaukee has largely increased the consumption of soft coal, and the improvement of other Wisconsin harbors has opened new channels for the distribution to interior points.

The following tables give receipts and shipments of coal at Milwaukee by rail and lake for the last five years:

*Receipts of coal at Milwaukee, Wis., 1903–1907, in short tons.*

| Source. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| By lake from— | | | | | |
| Buffalo | 914,901 | 809,471 | 800,814 | 748,644 | 813,904 |
| Erie | 153,325 | 91,310 | 60,641 | 66,964 | 140,313 |
| Oswego | 7,003 | 22,000 | 4,369 | 8,002 | 28,428 |
| Cleveland | 436,834 | 341,658 | 247,878 | 560,475 | 740,785 |
| Ashtabula | 230,726 | 187,772 | 245,455 | 263,527 | 318,046 |
| Lorain | 104,549 | 194,361 | 159,788 | 157,515 | 204,873 |
| Sandusky | 213,124 | 254,014 | 359,427 | 362,408 | 457,582 |
| Toledo | 477,950 | 689,641 | 770,962 | 851,521 | 1,064,666 |
| Fairport | 65,981 | 22,800 | 23,051 | 25,627 | 50,041 |
| Ogdensburg | ........ | 3,972 | ........ | ........ | ........ |
| Huron, Ohio | 23,046 | 38,012 | 87,008 | 160,274 | 134,508 |
| Other ports | 21,912 | 41,323 | 75,739 | 149,115 | 88,366 |
| Total, lake | 2,649,351 | 2,696,334 | 2,835,132 | 3,354,072 | 4,039,512 |
| By railroad | 374,626 | 248,105 | [a] 322,332 | [a] 461,203 | [b] 309,995 |
| Receipts | 3,023,977 | 2,944,439 | 3,157,464 | 3,815,275 | 4,349,507 |

[a] Including 319,935 tons by car-ferry lines.

[b] Including 132,516 tons by car ferry.

*Shipments of coal from Milwaukee, Wis., 1903–1907, in short tons.*

| Shipped by— | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Chicago, Milwaukee and St. Paul Rwy | 350,505 | 569,330 | 668,509 | 631,205 | 698,040 |
| Chicago and Northwestern Rwy | 259,941 | 361,824 | 512,536 | 459,333 | 509,271 |
| Wisconsin Central R. R | 33,339 | 55,368 | 87,105 | 93,766 | 103,551 |
| Lake | 6,645 | 6,040 | 9,460 | 4,138 | ............ |
| Total | 650,430 | 992,562 | 1,277,610 | 1,188,442 | 1,310,862 |

*Total receipts of coal by lake at Milwaukee, Wis., 1903–1907, by kinds, in short tons.*

| Kind. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Anthracite | 946,596 | 876,169 | 802,083 | 756,646 | 858,402 |
| Bituminous | 1,702,755 | 1,820,165 | 2,033,049 | 2,597,426 | 3,181,110 |
| Total | 2,649,351 | 2,696,334 | 2,835,132 | 3,354,072 | 4,039,512 |

*Receipts of coal at Milwaukee, Wis., by lake and rail in 1865, 1870, 1880, 1890, and annually from 1900 to 1907, in short tons.*

| | | | |
|---|---|---|---|
| 1865 | 36,369 | 1902 | 1,641,095 |
| 1870 | 122,865 | 1903 | 3,023,977 |
| 1880 | 368,568 | 1904 | 2,944,439 |
| 1890 | 999,657 | 1905 | 3,157,464 |
| 1900 | 1,808,593 | 1906 | 3,815,275 |
| 1901 | 1,953,489 | 1907 | 4,349,507 |

## ST. LOUIS, MO.

The following summary of the coal trade of St. Louis for 1907 has been prepared for this report by Mr. William Flewellyn Saunders, secretary and general manager of the Business Men's League of that city:

Notwithstanding the business depression throughout the United States during the last half of the year of 1907 St. Louis showed a healthy increase in the fuel trade. The increase in soft coal, which is used most for manufacturing purposes, shows an even greater increase for 1907 over 1906 than does the year 1906 show over 1905. Anthracite coal shows a phenomenal increase for the year 1907 over 1906—about 52.4 per cent. This is due in a large measure to a readjustment of freight transportation rates which make shipment from the anthracite districts of the East to the West by St. Louis cheaper than by other western distributing centers, but even the increase in the local use of anthracite is about 33⅓ per cent over 1906 for 1907. St. Louis is growing very steadily and especially in manufacturing, so that the depression which affected the nation was more than offset in St. Louis by the natural growth of the first half of the year.

*Coal prices at St. Louis, Mo., during 1906 and 1907, per short ton.*

| Kind. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Closing. | Highest. | Lowest. | Closing. |
| Standard Illinois lump coal | $2.85 | $1.45 | $1.70 | $2.07 | $1.47 | $1.65 |
| High-grade Illinois lump coal | 3.05 | 1.85 | 2.50 | 3.12 | 2.12 | 2.62 |
| Anthracite, large | 6.85 | 6.35 | 6.85 | 6.85 | 6.35 | 6.85 |
| Anthracite, small | 7.10 | 6.60 | 7.10 | 7.10 | 6.60 | 7.10 |
| Connellsville coke | 6.65 | 5.45 | 6.65 | 6.75 | 5.25 | 6.75 |
| New River coke | 6.45 | 5.30 | 6.45 | ........ | ........ | ........ |
| Kentucky coke | 4.10 | 3.60 | 4.10 | 4.15 | 3.75 | 4.15 |
| Gas coke | 5.00 | 3.70 | 4.90 | 5.25 | 3.85 | 5.25 |

*Coal and coke receipts at St. Louis, Mo., 1901–1907.*

| Year. | Soft coal. | Hard coal. | Coke. | Year. | Soft coal. | Hard coal. | Coke. |
|---|---|---|---|---|---|---|---|
| | *Bushels.* | *Tons.* | *Bushels.* | | *Bushels.* | *Tons.* | *Bushels.* |
| 1901 | 118,860,775 | 200,797 | 11,746,592 | 1905 | 171,727,675 | 158,843 | 12,350,278 |
| 1902 | 130,145,350 | 60,944 | 8,180,000 | 1906 | 190,540,325 | 174,226 | 18,244,444 |
| 1903 | 159,221,625 | 165,920 | 11,414,720 | 1907 | 211,936,900 | 265,571 | 20,660,000 |
| 1904 | 170,970,875 | 155,097 | 8,558,100 | | | | |

## PRODUCTION OF COAL BY STATES AND TERRITORIES.

Including Idaho, Nebraska, and Nevada, in which a few thousand tons of coal were produced, there were 31 States and Territories which contributed to the total production in 1907 against 30 coal-producing States and Territories in 1906. North Carolina, whose production had shown a gradual decrease since 1902, reported no production in either 1906 or 1907. Of the 31 States and Territories which produced coal in 1907, 12 are east of the Mississippi River and 19 are west of it. In 1907 the 12 States east of the Mississippi River produced 425,739,953 short tons, or 88.6 per cent of the total output, against 365,559,933 short tons, or 88.5 per cent in 1906, while the 19 States west of the Mississippi River produced 54,623,471 short tons, or 11.4 per cent in 1907 against 48,597,345 short tons, or 11.5 per cent in 1906. Of the 12 States east of the Mississippi, 6 are situated north of the dividing line formed by the Ohio and Potomac rivers, and 6 lie south of that natural boundary. The 6 States north of the 2 rivers produced in 1907 340,761,253 short tons, or 70.9 per cent of the total production, while the southern States contributed 84,978,700 short tons, or 17.7 per cent of the total production. While the northern States excel the southern States to such an extent in the total production, the ratio of increase since 1880 has been decidedly in favor of the latter. In 1880 the northern States produced 63,044,558 short tons and the southern States, 3,793,308 tons, the former being about 17 times the latter. In 1890 the northern States produced 122,296,267 short tons, which was about 7 times the 17,378,754 short tons produced in the southern States. In 1900 the southern States produced 42,607,053 short tons and the northern States 193,324,621, less than 5 times that of the southern States. In 1906 the production of the southern States was more than one-fourth that of the northern, and in 1907 it was almost exactly one-fourth. The States west of the Mississippi River have increased their total production from 4,624,324 short tons in 1880 to 54,623,471 in 1907.

In the following table is the production of the various States grouped according to geographical divisions made by the Mississippi, Ohio, and Potomac rivers, for the years 1880, 1890, 1900, 1906, and 1907, in order that the development of the different sections may be observed.

The production of coal in the several States and Territories in 1907 and preceding years is discussed more in detail in the following pages:

*Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1906, and 1907, in short tons.*

| State. | 1880. | | 1890. | | 1900. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Illinois | 6,115,377 | $8,779,832 | 15,292,420 | $14,171,230 | 25,767,981 | $26,927,185 |
| Indiana | 1,454,327 | 2,150,258 | 3,305,737 | 3,259,233 | 6,484,086 | 6,687,137 |
| Maryland | 2,228,917 | 2,585,537 | 3,357,813 | 2,899,572 | 4,024,688 | 3,927,381 |
| Michigan | 100,800 | 224,500 | 74,977 | 149,195 | 849,475 | 1,259,683 |
| Ohio | 6,008,595 | 7,719,667 | 11,494,506 | 10,783,171 | 18,988,150 | 19,292,246 |
| Pennsylvania: | | | | | | |
| Anthracite | 28,711,379 | 42,282,948 | 46,468,641 | 66,383,772 | 57,367,915 | 85,757,851 |
| Bituminous | 18,425,163 | 18,567,129 | 42,302,173 | 35,376,916 | 79,842,326 | 77,438,545 |
| Total | 63,044,558 | 82,309,871 | 122,296,267 | 133,023,089 | 193,324,621 | 221,290,028 |

| State. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Illinois | 41,480,104 | $44,763,062 | 51,317,146 | $54,687,382 |
| Indiana | 12,092,560 | 13,116,261 | 13,985,713 | 15,114,300 |
| Maryland | 5,435,453 | 6,474,793 | 5,532,628 | 6,623,697 |
| Michigan | 1,346,338 | 2,427,404 | 2,035,858 | 3,660,833 |
| Ohio | 27,731,640 | 30,346,580 | 32,142,419 | 35,324,746 |
| Pennsylvania: | | | | |
| Anthracite | 71,282,411 | 131,917,694 | 85,604,312 | 163,584,056 |
| Bituminous | 129,293,206 | 130,290,651 | 150,143,177 | 155,664,026 |
| Total | 288,661,712 | 359,336,445 | 340,761,253 | 434,659,040 |

*Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1906, and 1907, in short tons.*

| State. | 1880. | | 1890. | | 1900. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 323,972 | $476,911 | 4,090,409 | $4,202,469 | 8,394,275 | $9,793,785 |
| Georgia | 154,644 | 231,605 | 228,337 | 238,315 | 315,557 | 370,022 |
| Kentucky | 946,288 | 1,134,960 | 2,701,496 | 2,472,119 | 5,328,964 | 4,881,577 |
| North Carolina | 350 | 400 | 10,262 | 17,864 | 17,734 | 23,447 |
| Tennessee | 495,131 | 629,724 | 2,169,585 | 2,395,746 | 3,509,562 | 4,003,082 |
| Virginia | 43,079 | 99,802 | 784,011 | 589,925 | 2,393,754 | 2,123,222 |
| West Virginia | 1,829,844 | 2,013,671 | 7,394,654 | 6,208,128 | 22,647,207 | 18,416,871 |
| Total | 3,793,308 | 4,587,073 | 17,378,754 | 16,124,566 | 42,607,053 | 39,612,006 |

*Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1906, and 1907, in short tons*—Continued.

| State. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Alabama | 13,107,963 | $17,514,786 | 14,250,454 | $18,405,468 |
| Georgia | 332,107 | 424,004 | 362,401 | 499,686 |
| Kentucky | 9,653,647 | 9,809,938 | 10,753,124 | 11,405,038 |
| North Carolina | ........ | ........ | ........ | ........ |
| Tennessee | 6,259,275 | 7,667,415 | 6,810,243 | 8,490,334 |
| Virginia | 4,254,879 | 4,183,991 | 4,710,895 | 4,807,533 |
| West Virginia | 43,290,350 | 41,051,939 | 48,091,583 | 47,846,630 |
| Total | 76,898,221 | 80,652,073 | 84,978,700 | 91,454,689 |

*Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1906, and 1907, in short tons.*

| State or Territory. | 1880. | | 1890. | | 1900. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Arkansas | 14,778 | $33,535 | 399,888 | $514,595 | 1,447,945 | $1,653,618 |
| California | 236,950 | 663,013 | 110,711 | 283,019 | 172,908 | 540,031 |
| Colorado | 462,747 | 1,041,350 | 3,094,003 | 4,344,196 | 5,244,364 | 5,858,036 |
| Idaho | ........ | ........ | ........ | ........ | 10 | 50 |
| Indian Territory | ........ | ........ | 869,229 | 1,579,188 | 1,922,298 | 2,788,124 |
| Iowa | 1,461,116 | 2,507,453 | 4,021,739 | 4,995,739 | 5,202,939 | 7,155,341 |
| Kansas | 771,442 | 1,517,444 | 2,259,922 | 2,947,517 | 4,467,870 | 5,454,691 |
| Missouri | 884,304 | 1,464,425 | 2,735,221 | 3,382,858 | 3,540,103 | 4,280,328 |
| Montana | 224 | 800 | 517,477 | 1,252,492 | 1,661,775 | 2,713,707 |
| Nebraska | 200 | 750 | 1,500 | 4,500 | ........ | ........ |
| New Mexico | ........ | ........ | 375,777 | 504,390 | 1,299,299 | 1,776,170 |
| North Dakota | ........ | ........ | 30,000 | 42,000 | 129,883 | 158,348 |
| Oregon | 43,205 | 97,810 | 61,514 | 177,875 | 58,864 | 220,001 |
| Texas | ........ | ........ | 184,440 | 465,900 | 968,373 | 1,581,914 |
| Utah | 14,748 | 33,645 | 318,159 | 552,390 | 1,147,027 | 1,447,750 |
| Washington | 145,015 | 389,046 | 1,263,689 | 3,426,590 | 2,474,093 | 4,700,068 |
| Wyoming | 589,595 | 1,080,451 | 1,870,366 | 3,183,669 | 4,014,602 | 5,457,953 |
| Total | 4,624,324 | 8,829,722 | 18,113,635 | 27,656,918 | 33,752,353 | 45,786,130 |

| State or Territory. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Arkansas | 1,864,268 | $3,000,339 | 2,670,438 | $4,473,693 |
| California | [a] 30,831 | 78,684 | [a] 24,089 | 91,813 |
| Colorado | 10,111,218 | 12,735,616 | 10,790,236 | 15,079,449 |
| Idaho | [b] 6,165 | 24,238 | [c] 7,588 | 31,119 |
| Iowa | 7,266,224 | 11,619,455 | 7,574,322 | 12,258,012 |
| Kansas | 6,024,775 | 8,979,553 | 7,322,449 | 11,159,098 |
| Missouri | 3,758,008 | 6,118,733 | 3,997,936 | 6,540,709 |
| Montana | 1,829,921 | 3,240,357 | 2,016,857 | 3,907,082 |
| Nebraska | ........ | ........ | (d) | (d) |
| New Mexico | 1,964,713 | 2,638,986 | 2,628,959 | 3,832,128 |
| North Dakota | 305,689 | 451,382 | 347,760 | 560,199 |
| Oklahoma (Indian Territory) | 2,860,200 | 5,482,366 | 3,642,658 | 7,433,914 |
| Oregon | 79,731 | 212,338 | 70,981 | 166,304 |
| Texas | 1,312,873 | 2,178,901 | 1,648,069 | 2,778,811 |
| Utah | 1,772,551 | 2,408,381 | 1,947,607 | 2,959,769 |
| Washington | 3,276,184 | 5,908,434 | 3,680,532 | 7,679,801 |
| Wyoming | 6,133,994 | 8,013,528 | 6,252,990 | 9,732,668 |
| Total | 48,597,345 | 73,091,291 | 54,623,471 | 88,685,169 |

[a] Includes Alaska. [b] Includes Nevada. [c] Includes Nebraska and Nevada. [d] Included in Idaho.

## ALABAMA.

Total production in 1907, 14,250,454 short tons; spot value, $18,405,468.

The coal production of Alabama in 1907 showed an increase of 1,142,491 tons, or 8.72 per cent in quantity, and an increase of $890,682, or 5.09 per cent, in value. All of this increase in production in 1907 was made during the first nine months of the year, the gain prior to the 1st of October having exceeded the total increase for the year. During the last quarter a large number of iron furnaces went out of blast, coke ovens were cooled, and the consumption of coal decreased approximately one-half. In the latter part of 1906 and the first few months of 1907 some of the highest prices ever obtained for Alabama coal were reached, $2 per ton f. o. b. cars at the mines having been quoted during that time. The year 1907 opened with an unprecedented demand for coal, with which the production was unable to keep up, partly because of scarcity of cars on many of the railroads and partly owing to a shortage of labor. By the 1st of July the car supply had improved, with a somewhat slackened demand for coal, and by the end of the third quarter the car supply was sufficient to meet the requirements. With the decreased production in the last three months of the year there naturally followed a surplus of labor. The decreased output in the last three months of the year was accompanied also by a sharp decline in values, and the average price per ton fell from $1.34 in 1906 to $1.29 in 1907, notwithstanding the exceptionally high prices which were quoted early in the year.

The total number of men employed in the mines of Alabama in 1907 was 21,388 as against 20,555 in 1906. The average number of working days in 1907 was 242, against 237 in 1906.

The statistics for 1907 show an increased efficiency among the mine workers, as based upon the average production per man for each day and for the year. The average production for each man employed in 1907 was 666 tons, against 637.7 tons in 1906 and 605.6 in 1905. The average production per man per day in 1907 was 2.75 tons as compared with 2.69 tons in both 1906 and 1905.

According to the returns to the United States Geological Survey there were 197 machines used in the undercutting of coal in the mines of Alabama during 1907 as against 238 in 1906, a decrease of 41 in the number of machines used. Part of this decrease is accounted for from the fact that some machines were used, during 1906, in two or more mines of the same company and were reported from all of these mines, some of the machines thus being reported twice, and in some instances three times. The quantity of coal undercut by the use of machines amounted to 1,762,948 short tons, or 12.37 per cent of the total production, in 1907, against 1,641,476 tons, or 12.52 per cent, in 1906. Of the total number of machines used in 1907, 152 were of the pick or puncher type, 42 were chain-breast machines, and 3 were of the long-wall type.

Labor troubles were reported at only one mine in Alabama during 1907. In this case 80 men were idle for 45 days. The effect of this strike upon the total production was insignificant.

Most of the coal mines of Alabama are operated on the basis of a 10-hour day, 84 mines, employing a total of 13,942 men, having reported

10 hours as the length of the working day in 1907. Thirty-four mines, employing 2,339 men, worked 9 hours a day, and 31 mines, employing 1,994 men, worked 8 hours.

The accident statistics, as reported by Mr. J. M. Gray, State mine inspector, show that there were 154 men killed and 85 injured in the coal mines of Alabama during 1907, as compared with 96 killed and 89 injured in 1906. The increase in the number of fatalities in 1907 was due to the explosion at the mine of the Yolande Coal and Coke Company, at Yolande, in December, which resulted in the death of 56 men. The total number of deaths due to explosions of gas and dust was 62; 5 were caused by powder explosions or windy shots; 24 were due to falls of roof or coal, and 63 deaths were due to miscellaneous causes. The death rate per thousand employees was 7.20 in 1907, against 4.67 in 1906 and 9.44 in 1905. The number of tons mined for each life lost was 92,535 in 1907, against 136,541 in 1906 and 64,141 in 1905.

Of the total production of coal in Alabama in 1907, 4,193,545 tons were washed at the mines, there being 24 mines in the State where washeries have been established. These 24 washeries included 82 jigs, and the washing operations resulted in the production of 3,750,418 tons of cleaned coal and 443,127 tons of refuse. There are some washeries which are operated in connection with coke ovens at points distant from the mines. The coal washed at these plants is not included in the preceding statement.

The statistics of production in Alabama in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Alabama in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bibb | 1,236,950 | 4,274 | 83,432 | | 1,324,656 | $1,921,915 | $1.42 | 244 | 1,790 |
| Etowah | 133,560 | 100 | | | 133,660 | 173,758 | 1.30 | 231 | 347 |
| Jefferson | 4,092,863 | 39,759 | 236,955 | 2,253,538 | 6,623,115 | 9,086,329 | 1.37 | 253 | 9,834 |
| St. Clair | 245,020 | 847 | 10,360 | | 256,227 | 341,163 | 1.33 | 196 | 528 |
| Shelby | 213,496 | 500 | 11,091 | | 225,087 | 331,487 | 1.47 | 220 | 608 |
| Tuscaloosa | 379,936 | 33,847 | 32,911 | 604,098 | 1,050,792 | 1,490,745 | 1.42 | 229 | 1,380 |
| Walker | 2,721,253 | 37,879 | 62,857 | 240,529 | 3,062,518 | 3,586,167 | 1.17 | 218 | 5,149 |
| Winston | 26,701 | 375 | | | 27,076 | 44,617 | 1.65 | 187 | 85 |
| Other counties [a] | 359,226 | 12,800 | 9,106 | 22,200 | 403,332 | 536,550 | 1.33 | 215 | 834 |
| Small mines | | 1,500 | | | 1,500 | 2,055 | 1.37 | | |
| Total | 9,409,005 | 131,881 | 446,712 | 3,120,365 | 13,107,963 | 17,514,786 | 1.34 | 237 | 20,555 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bibb | 1,201,181 | 4,737 | 88,079 | 3,161 | 1,297,158 | $1,958,861 | $1.52 | 247 | 1,885 |
| Etowah | 194,340 | 5,100 | 5,575 | | 205,015 | 306,151 | 1.49 | 243 | 312 |
| Jefferson | 5,379,715 | 138,866 | 275,239 | 1,693,458 | 7,487,278 | 9,469,091 | 1.26 | 249 | 10,936 |
| St. Clair | 267,171 | 1,701 | 14,934 | | 283,806 | 402,276 | 1.42 | 231 | 502 |
| Shelby | 261,527 | 1,100 | 21,457 | | 284,084 | 395,170 | 1.39 | 249 | 665 |
| Tuscaloosa | 550,429 | 4,394 | 40,314 | 452,227 | 1,047,364 | 1,435,161 | 1.37 | 254 | 1,267 |
| Walker | 2,920,081 | 50,255 | 66,767 | 217,816 | 3,254,919 | 3,873,414 | 1.19 | 224 | 4,945 |
| Winston | 35,058 | 230 | 45 | | 35,333 | 61,163 | 1.73 | 178 | 109 |
| Other counties [a] | 334,950 | 9,682 | 10,383 | | 355,015 | 503,487 | 1.42 | 236 | 767 |
| Small mines | | 482 | | | 482 | 694 | | | |
| Total | 11,144,452 | 216,547 | 522,793 | 2,366,662 | 14,250,454 | 18,405,468 | 1.29 | 242 | 21,388 |

[a] Blount, Cullman, Dekalb, Jackson, and Marion.

In the following table is presented a statement of the production of coal in Alabama, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906:

*Coal production of Alabama, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Bibb | 1,651,157 | 1,386,079 | 1,335,923 | 1,324,656 | 1,297,158 | − 27,498 |
| Blount<br>Cullman | [a]260,802 | [a]279,070 | [a]294,550 | 337,848 | 336,308 | − 1,540 |
| Etowah | 119,830 | 128,989 | 170,484 | 133,660 | 205,015 | + 71,355 |
| Jefferson | 6,194,832 | 5,821,663 | 5,873,268 | 6,623,115 | 7,487,278 | + 864,163 |
| St. Clair | 152,313 | 144,223 | 186,595 | 256,227 | 283,806 | + 27,579 |
| Shelby | 240,962 | 128,307 | 157,569 | 225,087 | 284,084 | + 58,997 |
| Tuscaloosa | 610,392 | 663,412 | 885,361 | 1,050,792 | 1,047,364 | − 3,428 |
| Walker | 2,365,385 | 2,583,473 | 2,845,617 | 3,062,518 | 3,254,919 | + 192,401 |
| Winston | 50,841 | 40,356 | 40,109 | 27,076 | 35,333 | + 8,257 |
| Other counties and small mines | 7,810 | [b]86,474 | 76,593 | [b]66,984 | 19,189 | − 47,795 |
| Total | 11,654,324 | 11,262,046 | 11,866,069 | 13,107,963 | 14,250,454 | +1,142,491 |
| Total value | $14,246,798 | $13,480,111 | $14,387,721 | $17,514,786 | $18,405,468 | + $890,682 |

[a] Includes production of Marion County. [b] Includes Dekalb and Jackson counties.

The Alabama coal fields form the southwestern end of the great Appalachian coal region, which extends from northern Pennsylvania to central Alabama. The coal-bearing formations narrow in Tennessee, but widen abruptly in northern Alabama and cover about 6,000 square miles in the northern half of the State. There are four distinct coal-producing basins or districts in the State—the Coosa and Cahaba basins, and the Warrior and Plateau fields. The first three areas mentioned derive their names from the rivers which drain them. The Plateau field includes Blount, Lookout, and Sand or Raccoon mountains.

The Coosa basin is a deep syncline forming the southeast margin of the Alabama coal fields and extending across Shelby and St. Clair counties. It is 60 miles long by 6 miles wide and contains about 350 square miles. This basin has not been thoroughly explored, and the number and extent of its coal beds are not well known, but in different parts 2 to 12 seams are reported having a thickness of 3 feet or more.

The Cahaba basin is also a syncline west of the Coosa basin, to which it is parallel and from which it is separated by a faulted anticlinal valley. It includes parts of St. Clair, Jefferson, Shelby, and Bibb counties. Its length is 68 miles, its average width about 6 miles, and its area 394 square miles. There are many workable seams, and the total quantity of coal in the basin is large.

The Warrior basin is separated from the Cahaba basin and Blount Mountain by Jones and Murphrees valleys. It includes all of Walker County, most of Jefferson, Tuscaloosa, and Fayette counties, and smaller parts of Blount, Cullman, Winston, and Marion counties. Its known area is estimaed at 4,000 square miles. Around its western and southern margin, however, the higher rocks and coal beds pass under rocks of much later age, and have probably a considerable, and possibly a great, extent to the southwest of their visible margin. This basin has always been the scene of the greatest mining activity and production in the State. Somewhat over one-third of the total production in the Birmingham district comes from the Pratt seam, and one-fourth comes from the Mary Lee seam. From 8 to 10 other seams furnish the remainder of the production.

The Plateau field embraces parts of Blount, Etowah, Dekalb, Cherokee, Marshall, and Jackson counties, and is upward of 3,000 square miles in extent. The Plateau and Warrior fields are the southwest extension of the Cumberland plateau in Tennessee. The coal resources of the Plateau field are not well known, but they are comparatively small. There are believed to be from 4 to 6 seams that are locally workable.

So far as known the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the civil war, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham, and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted for two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of over 10,000,000 tons, and reached the maximum of 14,250,454 tons in 1907.

The statistics of coal production in Alabama from 1840 are found in the table on a preceding page, giving the statistical history of coal mining in the United States from the earliest times to the close of 1907.

According to the estimates prepared by Mr. Marius R. Campbell, of the United States Geological Survey, the original coal supply of Alabama when mining began was 68,903,000,000 short tons, of which 63,513,000,000 tons were in the Warrior and Plateau fields; 2,994,000,000 tons were in the Cahaba field, and 2,396,000,000 tons, in the Coosa field. From this total supply of approximately 69,000,000,000 tons there had been mined at the close of 1907, 164,734,310 tons, representing an exhaustion, including waste in mining, of 247,000,000 tons, or a little over 0.3 of 1 per cent of the total estimated supply.

The production of coal in Alabama in 1907 was something over 8 per cent of the total production up to the close of the year, and a little over 0.02 of 1 per cent of the estimated original supply.

## ALASKA.

Total production in 1907, 10,139 short tons; spot value, $53,600.

In 1907 there were only four coal producers in Alaska, as compared with five in 1906. One important advance was made, however, this being the first attempt which was made to develop the high-grade coals of the Controller Bay region. Although the number of producers was less, the production increased 4,598 tons, or 82.98 per cent in quantity, and $35,626, or practically 200 per cent in value. Considerable coal was mined on Bering Lake for local use, and its production was of very material benefit to the railway construction which was going on in the vicinity. Worthy of note is the reported easterly extension of the Controller Bay coal fields. Coal is reported to occur in the high ranges back of Bering Glacier and also near Yaktag. A coal mine in the Seward Peninsula continued to produce coal for local use, and one small mine on the Alaska Peninsula was also being operated for local use. In the Matanuska field much prospecting has been done, including some driving of tunnels. In the Controller Bay field prospecting has also been actively pushed, and the promise of a railway which is soon to reach the coal fields will accelerate the work in this region.

The lignite from the Yukon has been entirely neglected for the last two years; that is, since the introduction of oil-burning engines on the river steamers. This is to be regretted, because some of the lignites would undoubtedly furnish a valuable source of fuel, if they were systematically developed. On the Canadian side of the boundary considerable coal is mined and used at Dawson and other points. On the Alaskan side there was no coal mined in 1907, and as a consequence there was a proportionate devastation of the rather meager supply of timber. The Fairbanks district alone is estimated to use 35,000 cords of wood every year. The lignite coal field, lying on the upper waters of Nanana and stretching farther eastward toward the Delta, should furnish a coal supply, even if of low grade, were it opened up by a railway. It seems only too likely that the time will come when the Alaskan placer miner will feel the pinch for fuel, and then the lignite coals will have to be depended upon. It is even already noticeable that in many older camps the timber is getting very scarce. Much has been used for mining purposes and a far larger amount has been destroyed by forest fires.

The Alaskan coal fields, particularly those carrying a high-grade fuel, like the Controller Bay and Matanuska, are destined to play an important part in the advancement of industry on the entire Pacific seaboard of the North American Continent. Their early opening up is a vital question to all residents on the Pacific. The coal fields of Alaska are discussed in detail in the following publications of the Geological Survey:

17th Annual Report, Part VII; 22d Annual Report, Part III; Bulletins Nos. 213, 218, 225, 250, 259, 274, 277, 284, 289, 314, 327, and 335.

Considering the quantity of fuel consumed in Alaska by the steamers plying between the ports of the Pacific States and the Territory, the tardy development of what are known to be excellent coal beds in Alaska is somewhat remarkable. The following table showing the shipments of coal to Alaska has been prepared by Mr. George C. Martin, of the Division of Mineral Resources of Alaska. From this it appears that the annual consumption of coal in the Territory is between 135,000 and 160,000 short tons, compared with which the local production, even with the largely increased output in 1907, is insignificant.

*Shipments of coal to Alaska, 1904–1907, in short tons.*

| | 12 months ending June 30, 1904. | | 12 months ending June 30, 1905. | | 12 months ending June 30, 1906. | | 12 months ending June 30, 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Domestic anthracite | | | 6 | $85 | 0 | 0 | 533 | $7,090 |
| Domestic bituminous | 46,709 | $193,740 | 47,314 | 187,352 | 75,368 | $265,047 | 54,189 | 270,651 |
| Domestic coke | 439 | 2,251 | 535 | 4,281 | 389 | 3,676 | 3,481 | 25,629 |
| Canadian bituminous | 71,290 | 261,987 | [a] 66,397 | 260,266 | 46,463 | 187,348 | [a] 71,740 | 288,164 |
| Australian bituminous | 1,802 | 4,303 | | | | | 3,952 | 8,587 |
| Japanese bituminous | | | | | | | 12,932 | 33,789 |
| Foreign bituminous, shipped via United States | 3,723 | 23,904 | 6,216 | 29,673 | 1,127 | 6,638 | 4,638 | 28,679 |
| Total | 123,963 | 486,185 | 120,468 | 481,657 | 123,347 | 462,709 | 151,465 | 662,589 |

[a] Includes 28 tons of Canadian anthracite.

The following table shows the production of coal in Alaska since mining first began, in 1888. The figures up to 1898 are only approximations, as no accurate statistics were collected up to that time. The production for the later years, however, is presented from statistical data collected by actual correspondence with the producers. Up to 1906 practically all the coal mined was of a lignitic nature, though some of that mined on the lower Yukon and at Cape Lisburne several years ago was subbituminous. The delay in securing patents on Alaska coal lands has seriously hampered the coal-mining interests, and until the legal questions are settled no considerable advances can be expected.

*Production of coal in Alaska, 1888–1907.*

| Year. | Short tons. | Value. | Year. | Short tons. | Value. |
|---|---|---|---|---|---|
| 1888-1896 [a] | 6,000 | $84,000 | 1903 | 1,447 | $9,782 |
| 1897 | 2,000 | 28,000 | 1904 | 1,694 | 7,225 |
| 1898 | 1,000 | 14,000 | 1905 | 3,774 | 13,250 |
| 1899 | 1,200 | 16,800 | 1906 | 5,541 | 17,974 |
| 1900 | 1,200 | 16,800 | 1907 | 10,139 | 53,600 |
| 1901 | 1,300 | 15,600 | | | |
| 1902 | 2,212 | 19,048 | Total | 37,507 | 296,079 |

[a] The production for 1888-1898 is estimated on the best data obtainable. That for the later years subsequent to 1896 is based for the most part on data supplied by operators.

## ARKANSAS.

Total production in 1907, 2,670,438 short tons; spot value, $4,473,693.

If the record of the coal-mining industry of Arkansas in 1907 may be taken as an indication of the industrial conditions in the State, that year was the most prosperous in its history. During 1905 and 1906 the coal-mining industry of Arkansas was in a condition far from satisfactory. In fact, since 1903, when the production was 2,229,172 short tons, the output decreased each year until in 1906 it amounted to only 1,864,268 tons, valued at $3,000,339. A part of this decreasing tendency was attributed by some of the coal operators to discriminatory freight rates which restricted the market for Arkansas coal, and a statement to this effect was published in the report for 1906. Exception to this statement has been taken by the railroad companies, and the increase of 806,170 tons, or 43.3 per cent, in quantity, and of $1,473,354, or 49.11 per cent in value in 1907 over 1906, would indicate that if such discrimination existed in 1905 and 1906 it had been at least ameliorated in 1907. Complaint was made before the Interstate Commerce Commission by the operators in the Arkansas and the Oklahoma fields asking for a reduction in the freight rates to Texas and Louisiana. A hearing was held at South McAlester on November 19, 1907, and the case was argued before the Commission in Washington on May 16 of the present year (1908). The decision of the Commission had not been rendered at the time of the writing of this report.

The coal production of Arkansas in 1907 exceeded that of 1903, which was the year of largest previous output, by 441,266 tons in quantity and $1,112,862 in value. With the exception of Michigan, Arkansas's percentage of increase in coal production over the previous year was the highest in any of the coal-producing States.

The average price per ton received in 1907 was the highest in recent years, being $1.68, as against $1.61 in 1906, $1.49 in 1905, and $1.54 in 1904.

The decreased production in 1906, as compared with 1905, was due in part to the suspension of mining operations pending the settlement of the wage question. Nearly all of the mines in the State were shut down from April 1 until June 18, and in a few cases suspensions lasted beyond the latter date, some of the suspensions extending into August. The number of men idle during 1906 was 3,828 out of a total of 4,298 men employed. The average number of days lost by each of the 3,828 men was 76, and the total time lost was equivalent to 41 per cent of the time worked during the year. In 1907 there were 1,185 men idle for an average of 30 days, and the total time lost was equivalent to about 4 per cent of the total working time. In the report for 1906 it was stated that if the market could have taken all of the coal that it was possible to produce, the total production of the State would have amounted to 2,500,000 tons. This statement is well borne out by the record production of 2,670,438 tons in 1907.

The coal mines of Arkansas gave employment in 1907 to 5,085 men, who worked an average of 190 days, as against 4,298 men for an average of 165 days in 1906, and 4,192 men for an average of 177 days in 1905. The average production per man was 525 tons in 1907, against 433.8 tons in 1906, and 461.5 tons in 1905. The average tonnage per man per day in 1907 was 2.76, against 2.63 in 1906, and 2.6 in 1905.

During the last five years, or since the coal miners of Arkansas have been unionized, practically all of the mines have been operated on the basis of an 8-hour day.

On account of the change in the State mine inspectorship it has not been possible to secure the statistics of the coal mine accidents in Arkansas for the entire year. Mr. R. A. Young, the present mine inspector, reports that for the six months from July 1 to December 31, there were 10 fatal and 6 nonfatal accidents. Of the 10 fatal accidents, 5 were due to explosions of gas and dust, 1 to an explosion of powder, 1 to a fall of roof, 1 to a shaft accident, and 2 men were crushed by cars. Assuming that the production of coal in the last six months of the year was about the same as the first six months, and that the number of men employed was the same throughout the year, the number of tons of coal mined for each life lost was 133,522, and the death rate per thousand of employees was 3.93.

No machines have been used in the production of coal in Arkansas during the last 5 years.

Only one company has reported any effort to improve the quality of the Arkansas coal by washing. This company has 4 Stewart jigs in operation. In 1907 it washed 92,848 tons of coal, obtained 69,636 tons of cleaned coal and 23,212 tons of refuse. In 1906 it washed 36,309 tons of coal, which resulted in 27,711 tons of cleaned coal and 8,598 tons of refuse.

The statistics of production, by counties, for the last 2 years, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Arkansas in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Franklin and Johnson | 468,992 | 2,955 | 17,487 | 489,434 | $840,084 | $1.72 | 150 | 1,388 |
| Logan | 23,727 | 2,051 | 809 | 26,647 | 62,704 | 2.35 | 126 | 138 |
| Pope | 30,205 | 390 | 4,181 | 34,776 | 121,960 | 3.51 | 149 | 250 |
| Sebastian | 1,240,166 | 6,854 | 31,477 | 1,278,497 | 1,921,018 | 1.50 | 177 | 2,454 |
| Scott and Washington | 29,152 | 2,112 | 3,650 | 34,914 | 54,573 | 1.56 | 207 | 68 |
| Total | 1,792,242 | 14,362 | 57,664 | 1,864,268 | 3,000,339 | 1.61 | 165 | 4,298 |
| **1907.** | | | | | | | | |
| Franklin | 403,128 | 3,534 | 16,790 | 423,452 | $647,615 | $1.53 | 214 | 774 |
| Johnson | 235,555 | 2,648 | 5,080 | 243,283 | 512,477 | 2.11 | 149 | 772 |
| Logan | 27,683 | 1,603 | 684 | 29,970 | 73,767 | 2.46 | 201 | 89 |
| Pope | 38,389 | 404 | 8,960 | 47,753 | 163,267 | 3.42 | 165 | 237 |
| Sebastian | 1,806,737 | 9,972 | 58,677 | 1,875,386 | 3,009,026 | 1.60 | 197 | 3,111 |
| Scott and Washington | 44,734 | 4,554 | 1,306 | 50,594 | 67,541 | 1.33 | 133 | 102 |
| Total | 2,556,226 | 22,715 | 91,497 | 2,670,438 | 4,473,693 | 1.68 | 190 | 5,085 |

A statement of the production of coal in Arkansas, by counties, for the last 5 years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Arkansas, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Franklin | 394,884 | 408,494 | [a] 634,618 | [a] 489,434 | [a] 666,735 | + 177,301 |
| Johnson | 198,999 | 217,667 | ........ | ........ | ........ | ........ |
| Logan | 27,286 | 35,300 | 26,090 | 26,647 | 29,970 | + 3,323 |
| Pope | 48,836 | 51,488 | 39,685 | 34,776 | 47,753 | + 12,977 |
| Sebastian | 1,528,888 | 1,234,794 | 1,189,455 | 1,278,497 | 1,875,386 | + 596,889 |
| Other counties and small mines | [b] 30,279 | 61,708 | 44,825 | 34,914 | 50,594 | + 15,680 |
| Total | 2,229,172 | 2,009,451 | 1,934,673 | 1,864,268 | 2,670,438 | + 806,170 |
| Total value | $3,360,831 | $3,102,660 | $2,880,738 | $3,000,339 | $4,473,693 | +$1,473,354 |
| Average price per ton | $1.51 | $1.54 | $1.49 | $1.61 | $1.68 | ........ |

[a] Includes Johnson County.

[b] Includes also production of Perry County.

According to the United States census for 1840, a small quantity of coal (220 short tons) was mined in Arkansas during that year. With the exception of 9,972 short tons mined in Missouri and 400 tons from Iowa mines, this was the only coal produced west of the Mississippi River in that year, and for the next 20 years these were the only States west of the Mississippi from which any coal production was reported. The industry in Arkansas did not develop rapidly during the earlier years, as the census of 1860 shows a production of only 200 tons and that of 1880 a total of 14,778 short tons. During the last 20 years, with the exception of 1904, 1905, and 1906, the production has increased quite rapidly, reaching a maximum of 2,670,438 short tons in 1907.

A statement of the annual production of coal in Arkansas from 1840 to the close of 1907 will be found in the table on a preceding page, giving a history of coal production from the year of earliest record.

The total original supply of coal in Arkansas was 1,887,000,000 short tons,[a] of which 1,797,000,000 tons were bituminous and semianthracite and 90,000,000 tons were lignite. The lignite areas have not been developed and no production has been reported from them. From the bituminous and semianthracite areas there have been mined, to the close of 1907, 23,756,401 short tons, representing an exhaustion, including waste, of approximately 36,000,000 tons, or 2 per cent of the estimated original contents of the Arkansas fields. Of the total amount of coal produced in Arkansas from the time when mining began, 11 per cent was mined in 1907, in which year the output also represented about 0.15 of 1 per cent of the estimated original supply.[b]

## CALIFORNIA.

Total production in 1907, 13,950 short tons; spot value, $38,213.

In the report for 1906 mention was made of the demoralizing influence exerted by the increased production of petroleum, and its use for fuel purposes, on the production of coal in California, and this condition was accentuated in 1907, as shown by the returns for that year. The production of petroleum in California increased from 33,098,598 barrels in 1906 to 39,748,375 barrels in 1907, and the production of coal, which had decreased from 77,050 tons in 1905 to 25,290 tons in 1906, decreased still further in 1907 to 13,950 tons, the smallest production reported in the State since mining first began in 1861. During 1907, however, a considerable amount of development work was done in the Stone Canyon coal properties in Monterey County, and as soon as the transportation facilities, which are now in the course of construction, have been completed to this property, lying 25 miles from the Southern Pacific Railroad, an increase in the production of coal from California may be anticipated. The production and use of crude petroleum have almost eliminated coal for rail road and manufacturing purposes in California, but for domestic purposes there still remains a considerable market, and this has been supplied in the past partly from the sub-bituminous, or black lignite, mines of Mount Diablo and Corral Hollow fields in Alameda and

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[a] Coal fields of the United States, by Marius R. Campbell, U. S. G. S., 1908.

[b] For detailed description of the Arkansas coal field, see Bull. U. S. Geol. Survey, No. 316, Contributions to Economic Geology, 1906, p. 137.

Contra Costa counties, and by coal brought in from Oregon, Washington, and British Columbia, and also to some extent from Japan and Great Britain. The coal of Monterey County is a true bituminous coal and of much higher grade than that produced in other parts of the State or at Coos Bay in Oregon. It can be delivered in San Francisco and other cities in the State at less cost than the coal brought from other sources, and should find a profitable market.

The attempts at briquetting which have been made, and which have been discussed in previous reports and in Bulletin No. 316, do not seem to have resulted in the increased utilization of the subbituminous coals of Mount Diablo and Corral Hollow. It is probable that this is partly due to the fact that the form of briquettes are more suitable for power purposes than for domestic use, and this industry has suffered in sympathy with that of coal mining, because of the competition of fuel oil.

The statistics of production of coal in California in the last 5 years, with the distribution of the product for consumption, are shown in the following table:

*Distribution of the coal product of California, 1903–1907, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| 1903 | 83,339 | 6,808 | 14,526 | 104,673 | $294,736 | $2.82 | 307 | 203 |
| 1904 | 74,656 | 3,840 | 392 | 78,888 | 375,581 | 4.76 | 282 | 168 |
| 1905 | 74,000 | 550 | 2,500 | 77,050 | 382,725 | 4.97 | 294 | 135 |
| 1906 | 7,040 | 15,250 | 3,000 | [a] 25,290 | 60,710 | 2.40 | 284 | 41 |
| 1907 | 7,910 | 2,680 | 3,360 | 13,950 | 38,213 | 2.74 | 258 | 32 |

[a] In addition to this total there were 6,910 tons of bituminous coal mined in Monterey County, but not shipped during the year. This particular mine is located 25 miles from a railroad, and until transportation facilities are obtained the market for the product is limited to a restricted local demand.

There are in California a number of rather widely separated coal areas, chief among which have been the Mount Diablo and Corral Hollow fields in Alameda and Contra Costa counties. The development on a commercial scale, in the near future, of the bituminous coal area at Stone Canyon, and also in Priest Valley in Monterey County, is anticipated. This coal is of high grade, has a high calorific value, shows all the characteristics of bituminous coal, and does not slack or disintegrate upon exposure to the weather. Small quantities of coal have been mined in Kern, Monterey, Riverside, and Siskiyou counties, and in what is known as the Ione field in Amador County. Considerable prospecting of lignite beds has been carried on in Butte, Del Norte, Orange, Fresno, San Diego, Mendocino, Placer, and Trinity counties, and small quantities of coal have been produced from some of these prospects in the past, but little encouragement has been held out for any extensive development.

The records of the State mining bureau of California show a production of coal in that State as early as 1861. It was at that time one of the 15 coal-producing States. During the latter part of that decade and throughout the one following the production of California exceeded 100,000 tons annually and reached a maximum of 237,000 tons in 1880. Since 1881 the production has been irregular, having been largely influenced by the imports of Australia and British Columbia coals. The receipts of Australian coal have depended principally upon the wheat production and shipments from the Pacific coast. Vessels bringing Australian coal as return cargoes have had very low freight rates.

The history of the coal-mining industry in California from 1861 to the close of 1907 is exhibited in a table on a preceding page, which shows the production of coal in the United States from the earliest times.

### COLORADO.

Total production in 1907, 10,790,236 short tons; spot value $15,079,449.

Compared with 1906, when the coal production of Colorado amounted to 10,111,218 short tons, valued at $12,735,616, the statistics for 1907 show an increase of 679,018 tons, or 6.72 per cent in quantity, and of $2,343,833, or 18.4 per cent, in value. With the exception of one year (1904), Colorado's coal production has increased each year since 1894. The decrease in 1904 was not due to any slackened demand for coal, but to labor disturbances which interfered with the mining operations. In the 13 years from 1894 to 1907 the coal production of the State increased from 2,831,409 short tons to 10,790,236 tons, a gain of 7,958,827 tons, or 281.09 per cent. The output in 1907 was more than double that of 1900 and more than three times that of 1897, 10 years earlier.

The main feature of the coal-mining industry in 1907 was a general growth in prosperity throughout the year, and unusual activity was manifested in the opening and developing of new mines and in improvements in the older operations, particularly those controlled by the larger companies. These improvements were largely directed toward the greater safeguarding of life and property and consisted in the sinking of new air shafts and the installation of ventilating fans of larger capacity than those previously in use. The relations between the operators and the miners were for the most part amicable, the few disputes being of comparatively little consequence and of short duration. The chief difficulties occurred in the mines in the vicinity of Colorado Springs, where the miners were on strike for an advance of wages and an 8-hour day. At two of these mines, both in El Paso County, where the men went on strike on October 19, work was shortly resumed with nonunion labor, and the actual loss of time was unimportant. The total number of men reported on strike during the year was 215, who were idle for an average of 30 days each. There was some agitation in other parts of the State for an 8-hour day and for an increase in wages prior to October 1, but when as a result of the financial disturbance the banks stopped payment in cash, this agitation ceased. During the first of the year there was the usual shortage of men and cars at the coal-mining camps, and this retarded coal mining considerably, but at the close of the year, when many men were thrown out of employment as a result of the money stringency, this shortage, particularly in labor, was relieved. Previous to November the car supply was estimated to have been 25 per cent short of the requirements, but during the last two months of the year there was a full supply. The average price per ton in 1907 was

$1.40, as compared with $1.26 in 1906 and $1.22 in 1905, and altogether the year 1907 may be considered the most satisfactory in the history of coal mining in the State.

The total number of men employed in the coal mines of Colorado in 1907 was 14,223, who made an average of 258 working days, against 11,368 men, for an average of 268 days, in 1906. There was, however, a decrease in the average production per man, from 889.4 tons in 1906 to 759 tons in 1907. The average production per day for each man was 2.94 in 1907, as compared with 3.32 in 1906. In 1905 the average production per man for the year was 801, and per day 3.14 tons.

Most of the larger mines of the State are operated upon the basis of a 10-hour day, there being 54 mines, employing 7,439 men, which worked 10 hours in 1907; 60 mines, employing 3,420 men, worked 8 hours, and 8 mines, employing 312 men, worked 9 hours. At 7 mines employing a total of 2,226 men the miners were reported as working 8 hours and all other employees 10 hours.

The use of mining machines in the coal mines of Colorado continues to increase. The returns for 1907 show that there were 175 machines in use, as against 141 machines in 1906. The machine-mined product increased from 1,337,006 tons in 1906 to 1,689,517 tons in 1907. Of the 175 machines in use in 1907, 103 were of the pick or puncher type, 58 were chain machines, and 14 long-wall.

Mr. John D. Jones, State coal mine inspector, reports that in 1907 there were 99 men killed and 138 injured in the coal mines of Colorado. Of the total number of deaths, 25 were due to explosions of gas or dust, 3 to explosions of powder or misplaced shot, 52 to falls of roof, and 8 to suffocation; 9 men were killed by being crushed by cars or motors, 1 was killed by electric current, and 1 was killed in a shaft. The death rate per thousand of employees was 6.96 as against 7.7 in 1906, and the number of tons mined for each life lost was 108,992, as against 114,900 in 1906.

The statistics of production in Colorado in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Colorado in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Boulder | 963,810 | 25,398 | 32,888 | ........ | 1,022,096 | $1,578,579 | $1.54 | 220 | 1,147 |
| Delta | ........ | 6,717 | 95 | ........ | 6,812 | 11,688 | 1.72 | 197 | 14 |
| El Paso | 159,105 | 44,150 | 7,538 | ........ | 210,793 | 285,433 | 1.35 | 278 | 488 |
| Fremont | 632,033 | 7,661 | 26,340 | ........ | 666,034 | 1,264,590 | 1.90 | 241 | 1,085 |
| Garfield | 190,203 | 1,800 | 1,060 | ........ | 193,063 | 239,929 | 1.24 | 257 | 279 |
| Gunnison | 475,499 | 5,438 | 12,743 | 89,495 | 583,175 | 855,341 | 1.47 | 269 | 565 |
| Huerfano | 1,754,800 | 7,444 | 41,547 | ........ | 1,803,791 | 2,502,924 | 1.39 | 272 | 2,090 |
| La Plata | 156,137 | 9,711 | 3,006 | 4,867 | 173,720 | 295,519 | 1.70 | 272 | 254 |
| Las Animas | 2,960,686 | 38,940 | 102,332 | 1,666,924 | 4,768,882 | 4,856,949 | 1.02 | 287 | 4,727 |
| Mesa | 24,008 | 13,688 | ........ | ........ | 37,696 | 50,874 | 1.35 | 201 | 53 |
| Routt | ........ | 5,247 | 50 | ........ | 5,297 | 7,974 | 1.61 | 190 | 8 |
| Weld | 67,907 | 24,478 | 3,035 | ........ | 95,420 | 147,194 | 1.54 | 232 | 137 |
| Other counties[a] | 313,293 | 9,987 | 21,482 | 197,757 | 542,519 | 635,507 | 1.17 | 255 | 521 |
| Small mines | ........ | 1,920 | ........ | ........ | 1,920 | 3,115 | 1.62 | ........ | ........ |
| Total | 7,697,481 | 202,579 | 252,115 | 1,959,043 | 10,111,218 | 12,735,616 | 1.26 | 268 | 11,368 |

[a] Adams, Archuleta, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.

*Coal production of Colorado in 1906 and 1907, by counties, in short tons.*

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Boulder | 1,240,935 | 11,641 | 44,153 | .......... | 1,296,729 | $1,976,064 | $1.52 | 212 | 1,472 |
| Delta | 14,366 | 7,591 | 130 | .......... | 22,087 | 35,447 | 1.60 | 155 | 87 |
| El Paso | 150,110 | 112,690 | 6,995 | .......... | 269,795 | 394,402 | 1.46 | 209 | 277 |
| Fremont | 715,593 | 25,262 | 32,094 | .......... | 772,949 | 1,655,280 | 2.14 | 259 | 1,535 |
| Garfield | 211,930 | 2,764 | 5,346 | .......... | 220,040 | 282,091 | 1.28 | 208 | 288 |
| Gunnison | 495,166 | 6,744 | 12,769 | 74,180 | 588,859 | 885,015 | 1.50 | 228 | 697 |
| Huerfano | 1,742,418 | 8,458 | 46,914 | .......... | 1,797,790 | 2,799,133 | 1.56 | 251 | 2,511 |
| La Plata | 177,698 | 1,179 | 2,185 | 2,956 | 184,018 | 324,239 | 1.76 | 260 | 283 |
| Las Animas | 3,184,766 | 37,189 | 115,302 | 1,547,848 | 4,885,105 | 5,658,606 | 1.16 | 281 | 6,186 |
| Mesa | 40,148 | 4,030 | 352 | .......... | 44,530 | 85,233 | 1.91 | 200 | 62 |
| Routt | .......... | 5,690 | .......... | .......... | 5,690 | 10,530 | 1.85 | 218 | 10 |
| Weld | 109,971 | 20,817 | 5,286 | .......... | 136,074 | 222,269 | 1.63 | 226 | 198 |
| Other counties[a] | 326,523 | 11,824 | 24,753 | 201,280 | 564,380 | 747,405 | 1.32 | 281 | 617 |
| Small mines | .......... | 2,190 | .......... | .......... | 2,190 | 3,735 | 1.71 | .......... | .......... |
| Total | 8,409,624 | 258,069 | 296,279 | 1,826,264 | 10,790,236 | 15,079,449 | 1.40 | 258 | 14,223 |

[a] Adams, Archuleta, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.

In the following table is shown the total production of the State, by counties, during the last 5 years, with the increases and decreases in 1907 as compared with 1906:

*Coal production of Colorado, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Boulder | 803,924 | 736,824 | 839,804 | 1,022,096 | 1,296,729 | + 274,633 |
| Delta | 13,029 | 21,683 | 9,497 | 6,812 | 22,087 | + 15,275 |
| El Paso | 207,797 | 248,013 | 188,775 | 210,793 | 269,795 | + 59,002 |
| Fremont | 633,858 | 256,200 | 512,002 | 666,034 | 784,949 | + 106,915 |
| Garfield | 176,354 | 198,545 | 172,563 | 193,063 | 220,040 | + 26,977 |
| Gunnison | 436,604 | 494,545 | 513,317 | 583,175 | 576,859 | + 5,684 |
| Huerfano | 1,319,666 | 1,187,905 | 1,426,640 | 1,803,791 | 1,797,790 | − 6,001 |
| Jefferson | .......... | 129,168 | 189,235 | 212,037 | 193,814 | − 18,223 |
| La Plata | 143,637 | 146,080 | 168,669 | 173,720 | 184,018 | + 10,298 |
| Las Animas | 3,213,743 | 2,808,953 | 4,297,509 | 4,768,882 | 4,885,105 | + 116,223 |
| Pitkin | 342,054 | 269,006 | 342,804 | 319,529 | 313,866 | − 5,663 |
| Routt | 2,775 | 5,568 | 3,643 | 5,297 | 5,690 | + 393 |
| Weld | 94,492 | 118,862 | 101,812 | 95,420 | 136,074 | + 40,654 |
| Other counties | 35,669 | 37,003 | 60,069 | 50,569 | 103,420 | + 52,851 |
| Total | 7,423,602 | 6,658,355 | 8,826,429 | 10,111,218 | 10,790,236 | + 679,018 |
| Total value | $9,150,943 | $8,751,821 | $10,810,978 | $12,735,616 | $15,079,449 | +$2,343,833 |

The Colorado coal fields are grouped along the lower flanks and among the foothills of the mountainous portion of the State. They are thus naturally divided by the axes of the major mountain ranges, and have often been described as contained in three groups, namely, the Eastern, the Park, and the Western. These groups comprise the following distinct coal fields: The Eastern group, including the Trinidad, the Canyon City, and the South Platte fields; the Park group, including the fields of North and Middle Parks, and the Como field of South Park; the Western group is the largest and most important, including the Yampa field in the northwest, the various fields of the Grand River basin, extending from the valley of White River to those of the Grand and the Gunnison, a small, isolated field in Ouray County, and the field known as the Durango or La Plata, which is much more extensive in northwestern New Mexico than its Colorado portion.

The coal-bearing rocks of Colorado are mainly of Upper Cretaceous age. Some coal is mined from the Dakota and lower Colorado formations. The principal coal beds are found in the Mesaverde formation, which is of Montana Cretaceous age, much of which was formerly considered to belong to the Laramie formation. Above the Mesaverde, coal is also found in the Laramie, and also in the later Tertiary formations.

The coals in Colorado are of practically all classes, ranging from the poorer grades of lignite to high grade bituminous, coking coals, and anthracite. Some of the lower grade coals of the eastern fields have been very extensively mined on account of their greater accessibility to the Denver and other markets. The high grade coals of the Trinidad field have also been extensively worked. The coal fields of the interior or Park districts are less well known, especially those of the Middle and North Park fields.

The fields now attracting most attention are those in the western part of the State, and especially those of the Yampa coal field of Routt County. The recent prominence of this field is largely due to its prospective availability, being situated directly along the projected line of the Denver, Northwestern and Pacific Railroad, now building in the Yampa Valley. Most of the coal is of excellent quality, being a steaming coal of high grade. Anthracite occurs in a small field in the vicinity of Pilot Knob and is also reported in the Flattops west of the town of Yampa. Its occurrence there is due to the metamorphic action of intrusive igneous rock, and it is consequently of local and somewhat limited extent. A large extent of territory, containing thick beds of coal of Laramie age and of somewhat lower grade than the Mesaverde coal, is practically untouched in this field, but it is certain to become valuable as the higher grades become exhausted.

An equally valuable field in the Danforth Hills lies along the upper valley of White River, south of Axial Basin. The coals found there are equal in quality and in thickness and number of coal beds to those of the Yampa field, but do not appear to be so readily accessible to the prospective railroad route. The coal fields extend westward on lower White River and southward along the Grand Hogback to Grand River and beyond, where they are already extensively developed in many places. Excellent coals are mined and coked in Pitkin County and the product shipped east across the mountains to the smelters. The anthracite of the Crested Butte region has long been known. An extensive field on Grand and Gunnison rivers is continuous with equally important fields of Utah, also yielding some high grade steaming and coking coals.

The area of Colorado coal fields as previously mapped has been somewhat extended by the investigations of the past field season (1907) in the lower White River valley. An area of 250 to 300 square miles hitherto described in the geological reports as occupied wholly by Tertiary strata, and which was therefore supposed to contain the valuable Tertiary coals buried beyond available depth, has been found, in fact, to be almost entirely composed of the outcrop of the principal coal-bearing rocks. The field contains a considerable number of valuable coal beds. This new field is situated in the valley of Douglas Creek, south of Rangely or Raven Park, and just north of the Book Cliffs divide, near the Grand Junction coal field. The coal beds are of the same group as those mined north of Grand River, near the Colorado-Utah State line. The group is with little doubt continuous with a corresponding group of the Grand River coal beds, these beds being covered by the Tertiary strata across the highest summits of the divide. The Douglas Creek field is limited by the Cathedral Bluffs on the east, by the high ridges and divide of the Book Cliffs on the south, and it gradually dips beneath the cover of overlying Tertiaries to the west, its coal passing beyond accessible depth somewhere in the vicinity of the State line. Dragon, Utah, is the nearest railroad point, but the coals are best exposed and most readily reached in the eastern half of the field, or along the main forks of Douglas Creek itself. At present, therefore, the field is relatively inaccessible to present railroad lines, and owing to the inadequacy of the present land surveys it was not examined nor classified in detail in the work of the past season.

The fields in the southwestern part of the State have been well known for some time. The accessibility of the coal and the growth of the metal mining and smelting interests in that region have contributed to a more extensive development of the coal resources of the southern part of the State than has obtained in most of the fields farther north.

A summary of the geologic work in the coal fields of Colorado will be found in the yearly progress reports, contained in Bulletins 285 and 316, already issued.

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded for that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six years later, in 1882, had reached the million-ton mark. Since that date the increase has been almost uninterrupted, there being only three instances, ten years apart (in 1884, 1894, and 1904), when the production showed a decrease of any importance, and only four altogether in thirty-six years. The largest decrease was made in the "hard-times" year of 1894. The coal production of the State exceeded 3,000,000 tons in 1890; ten years later it had grown to over 5,000,000 tons, and it amounted to nearly 11,000,000 tons in 1907. The record by years will be found in a table on a preceding page, giving the statistical history of coal production in each State from the earliest times to the close of 1907.

Mr. Campbell's estimate[a] of the coal fields of Colorado shows that the area containing, or which may contain, workable coal beds, amounts to 17,130 square miles, of which 10,130 square miles are estimated to contain workable coal; 4,180 square miles may contain workable coal, but the information about this area is uncertain; and 2,820 square miles contain coal under heavy cover. The original contents of these areas is estimated to have been 371,770,000,000 short tons.

The production of coal in Colorado up to the close of 1907 aggregated 112,668,336 short tons, and assuming that for each two tons of coal mined one ton was wasted, this production represents an exhaustion of 169,000,000 short tons, or a little over 0.05 of 1 per cent of the estimated original supply.

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[a] Coal Fields of the United States. By Marius R. Campbell, U. S. Geol. Survey, 1908.

## GEORGIA.

Total production in 1907, 362,401 short tons, spot value, $499,686.

For the first time since 1903 the coal production of Georgia showed an increase over the preceding year. From a maximum production of 416,951 short tons in 1903, the output declined each year until in 1906 it amounted to 332,107 short tons, the smallest production reported since 1900. The statistics for 1907, however, show an increase of 30,294 short tons, or 9.12 per cent, in quantity over 1906, with an increase in value of $75,682, or 17.85 per cent. The entire production is confined to two counties, Dade and Walker, in the northwestern corner of the State, and as the area is of limited extent it is not probable that the production will show any material increase in the future.

The number of men employed in the coal mines of the State in 1907 was 808, who worked an average of 262 days, against 737 men for 279 days in 1906, and 801, for an average of 270 days, in 1905. The average production per man was 449 tons in 1907, as compared with 450.6 tons in 1906, while the average daily production for each employee was 1.71 in 1907, against 1.62 in the preceding year. The apparently low grade of efficiency in the coal miners of Georgia is explained by the fact that State convicts are employed to a considerable extent, under lease, and these in a large majority of cases have had for experience as coal miners only the periods of their incarceration.

Coal-mining machines are not employed in the State, and little interference by reason of labor troubles is experienced. No strikes have been reported in the coal mines of Georgia during the last three years.

The statistics of production of coal for the last five years, with the distribution of the product for consumption, are shown in the following table:

*Coal production of Georgia since 1903, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| 1903 | 267,369 | 812 | 2,218 | 146,552 | 416,951 | $521,459 | $1.25 | 298 | 681 |
| 1904 | 243,244 | 1,000 | 6,677 | 132,270 | 383,191 | 466,496 | 1.22 | 222 | 881 |
| 1905 | 224,695 | 1,148 | 7,113 | 119,035 | 351,991 | 453,848 | 1.29 | 270 | 801 |
| 1906 | 194,881 | 850 | 8,324 | 128,052 | 332,107 | 424,004 | 1.28 | 279 | 737 |
| 1907 | 204,890 | 5,780 | 10,700 | 141,031 | 362,401 | 499,686 | 1.38 | 262 | 808 |

Portions of two counties in the extreme northwestern corner of Georgia are underlain by the coal measures of the southern Appalachian coal fields. The Walden basin of Tennessee crosses Dade County in Georgia, and extending southwesterly becomes the Blount Mountain and Warrior basins in Alabama. The Lookout basin, a narrow outlying area, extends from Etowah County in Alabama in a northeasterly direction into Walker County, Ga. The total area of the coal fields in Georgia is estimated at 167 square miles, the smallest of any State coal fields, not all of it being workable. Extensive operations are carried on in both counties, however, some of this coal being highly prized as a steam fuel and finding a ready market for bunker coal at Brunswick and other coast cities. It also makes an excellent coke, and about 30 per cent of the output each year is made into coke, which is sold to the furnaces at Chattanooga and other points in Tennessee and Georgia.

The Eighth United States Census contains the first authentic statement of production of coal in Georgia. This report, which is for 1860, gives the production in that year as 1,900 short tons. The census for 1870 does not mention any production in Georgia for that year. The Tenth Census (1880) reports an output of coal for the State of 154,644 short tons, since which time the production has been reported in Mineral Resources of the United States. The statistics for each year since 1860 will be found in a statement on a preceding page, giving the production of coal, by States, from the earliest times to the close of 1907.

According to the estimates of Mr. M. R. Campbell, the total original coal supply of Georgia was 933,000,000 tons, from which there had been mined to the close of 1907, 8,123,696 short tons, representing (including loss in mining) an exhaustion of about 12,000,000 tons. This would leave still in the ground a total of 921,000,000 tons, of which from 600,000,000 to 650,000,000 tons would probably be considered as the available supply.

## IDAHO.

Total production in 1907, 6,508 short tons; spot value, $26,494.

There are several somewhat restricted areas in Idaho in which lignite beds occur, but little has been done there in the way of mining until the last five or six years. The districts from which this production has been obtained are the Horseshoe Bend and the Jerusalem, occupying the lower portion of a ridge between the Boise and the Payette rivers; one near Salmon City, in Lincoln County, and one at the eastern edge of the State, in Bingham and Fremont counties, where the Sublette field of Wyoming extends across the State line. The principal production in 1905 and 1906 was in the Salmon district, in Lemhi County, 4,380 tons having been mined there in 1905, and 4,285 tons out of a total of 5,365, in 1906. In 1907 Fremont County was credited with a production of 2,884 tons, and 3,500 tons were produced in Lemhi County. Bingham County also produced a small quantity of coal in 1907.

The total production in the State in 1907 showed an increase of 1,143 tons, or 21.3 per cent in quantity, and $7,956, or 42.92 per cent in value.

The production of coal in Idaho during the last six years has been as follows:

*Coal production of Idaho, 1902–1907, in short tons.*

| Year | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1902 | 2,030 | $5,180 | 1905 | 5,782 | $16,346 |
| 1903 | 4,250 | 13,250 | 1906 | 5,365 | 18,538 |
| 1904 | 3,330 | 12,230 | 1907 | 6,508 | 26,494 |

## ILLINOIS.

Total production in 1907, 51,317,146 short tons; spot value, $54,687,382.

With an increase of 9,837,042 short tons, or 23.72 per cent in quantity, and of $9,924,320, or 22.17 per cent, in value, over the production of 1906, Illinois again advanced to second place among the coal-producing States, a position it had held uninterruptedly since 1883 (when Illinois supplanted Ohio as the second in rank among the coal-producing States), and up to 1906, when Illinois was supplanted by West Virginia. The increase in the production of Illinois in 1907 was due in large measure to a heavy demand for coal, and also to the renewed activity in mining after the recovery from the effects of the suspension on April 1 of the year before. During this suspension practically all of the important mines of Illinois were idle, and 49,792 men out of a total of 61,988 in the State were idle for an average of 58 days, which is equivalent to about 25 per cent of the working time made. In West Virginia the suspension affected only a small number of the mines, and these only for about 30 days, so that the amount of time lost in West Virginia was only about 1.1 per cent of the time made. As a result of these conditions West Virginia in 1906 outranked Illinois by 1,810,246 short tons, and Illinois again dropped to third place among the coal-producing States. In 1907 Illinois's production surpassed that of West Virginia by 3,225,563 short tons.

In 1907 the time lost by labor disaffection was represented by 5,255 men being idle for an average of 7 days each, and this was not enough to adversely influence the production. The slightly less increase in value compared with the production in 1907 was due to the higher prices which obtained during the period of suspension in 1906. Illinois contains more coal-producing counties than any other State in the Union, there having been 52 counties which in 1907 produced 1,000 tons or more each. Of these there were 2 whose production in 1907 exceeded 5,000,000 tons, namely, Sangamon, 5,160,042 short tons, and Williamson, 5,697,944 tons. Two others produced over 4,500,000 tons: Macoupin, with 4,507,270 tons, and St. Clair, 4,511,879 tons. Madison County produced in 1907, 3,927,721 short tons; Bureau, 2,010,762 tons; Fulton, 2,113,643 tons; Saline, 2,247,842 tons, and Vermilion, 2,973,253 tons. Nine other counties each produced over 1,000,000 tons. The most important increases in 1907 over 1906 were in Saline and Williamson counties, each of which showed a gain of more than 1,250,000 tons. Other important gains were made by Macoupin County, with 869,443 tons; Clinton, 786,595 tons; Sangamon, 616,193; Madison, 602,864; Vermilion, 583,968; Montgomery, 568,606, and Fulton, 534,419 tons. During 1907 the usual complaint of car shortage was freely made, but the car supply was undoubtedly better than in previous years. The southern portion of the State suffered more than the northern, from car shortage, largely for the reason that the greatest increase in production was in the southern counties of the State, notably, as already stated, in the output of Saline and Williamson counties, whose aggregate increase exceeded 2,500,000 tons. The northern part of the State suffered more than the southern from a scarcity of miners, the coal beds being thinner in the northern, and the miners naturally drifting to those mines where the larger tonnage, and consequently more wages, could be secured for the same amount of work done. During the latter part of the year some difficulty was experienced with the mine laborers because of the operators' inability to procure currency for pay rolls, and the unwillingness of the miners to accept checks or clearing-house certificates in payment of their wages. This resulted in numerous shut-downs, which were, however, not of long duration, the average time lost for each man idle, as previously stated, being 7 days.

The number of men employed in the coal mines of Illinois in 1907 was 65,581, who worked an average of 218 days, as compared with 61,988 men for an average of 192 days in 1906, and 58,053 men, working an average of 201 days, in 1905. The average production per man for the year 1907 showed a material increase over 1906, as did also the average production per man per day. The average tonnage per man in 1907 was 782.5, against 669.2 in 1906, and 662.1 in 1905. The average daily tonnage per man was 3.59 in 1907; 3.49 in 1906, and 3.29 in 1905. A part, if not all, of this increased efficiency is due to the increased use of mining machines. In 1907 there were employed in the coal mines of Illinois 1,080 machines, with which a total of 15,134,401 tons, or 29.49 per cent of the total product, was won. In 1906, 11,585,419 tons, or 27.93 per cent of the total, were undercut by machines. The machine-mined product showed an increase of 3,548,982 short tons over that of 1906. Of the machines in use in 1907, 836 were of the pick or puncher type, 243 were chain-breast machines, and 1 was a long-wall machine.

The coal-mine workers of Illinois are probably better organized than those of any other of the bituminous coal-mining States, by far the larger number of the coal mines in the State working 8 hours per day. In 1907, out of a total of 65,581 men, 60,268 were reported as working 8 hours per day; 8 mines, employing a total of 675 men, worked 9 hours, and 1 small mine reported 10 hours as the length of the working day for the 4 men employed. There were 4,634 men whose length of working day was not reported, but most of these probably worked 8 hours.

The coal mines of Illinois have been remarkable in their freedom from dust or gas explosions during the last 2 years. In 1906 there were only 2 deaths attributable to this cause, and in 1907, out of a total of 172 men killed, as reported by Mr. David Ross, secretary of the bureau of labor statistics, 7 met death in gas or dust explosions; 92 were killed and 301 injured by falls of roof or coal; 26 were killed and 38 injured by powder explosions and misplaced shots; 33 were killed and 158 injured by being caught by the cars or motors; 2 were killed by electricity, and 7 men were killed and 10 injured in shaft accidents. Five deaths and 66 injuries were attributed to other causes.

The death rate per 1,000 men employed in 1907 was 2.62, and the number of tons mined for each life lost was but little less than 300,000.

During 1907 there were 2,988,386 short tons of Illinois coal washed before being shipped. The cleaned coal from the washeries amounted to 2,465,767 short tons, while the refuse amounted to 522,619 tons.

**The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:**

*Coal production of Illinois in 1906 and 1907, by counties, in short tons.*

### 1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bureau | 1,488,032 | 47,149 | 44,904 | ....... | 1,580,085 | $2,390,498 | $1.52 | 185 | 4,412 |
| Christian | 798,503 | 89,718 | 46,231 | ....... | 934,452 | 1,045,449 | 1.12 | 172 | 1,678 |
| Clinton | 467,661 | 14,118 | 34,017 | ....... | 515,796 | 510,351 | .99 | 146 | 811 |
| Franklin | 530,849 | 14,927 | 23,424 | ....... | 569,200 | 607,834 | 1.07 | 257 | 655 |
| Fulton | 1,508,594 | 37,949 | 32,681 | ....... | 1,579,224 | 1,909,349 | 1.21 | 208 | 2,468 |
| Gallatin | 59,430 | 20,728 | 2,500 | 10,073 | 92,731 | 93,963 | 1.01 | 185 | 177 |
| Grundy | 1,072,922 | 44,918 | 44,179 | ....... | 1,162,019 | 1,764,597 | 1.52 | 207 | 3,001 |
| Henry | 75,258 | 67,185 | 6,745 | ....... | 149,188 | 238,653 | 1.60 | 236 | 293 |
| Jackson | 551,937 | 32,352 | 61,907 | ....... | 646,196 | 819,174 | 1.27 | 156 | 1,228 |
| Knox | 13,086 | 38,168 | 400 | ....... | 51,654 | 85,393 | 1.65 | 161 | 138 |
| Lasalle | 1,130,149 | 293,109 | 44,414 | ....... | 1,467,672 | 2,366,626 | 1.61 | 200 | 3,513 |
| Livingston | 220,853 | 45,077 | 7,901 | ....... | 273,831 | 408,255 | 1.49 | 180 | 595 |
| Logan | 355,121 | 56,538 | 23,900 | ....... | 435,559 | 440,058 | 1.01 | 176 | 686 |
| McDonough | 32,431 | 11,143 | 200 | ....... | 43,774 | 81,262 | 1.86 | 178 | 123 |
| Macoupin | 3,415,475 | 85,827 | 136,525 | ....... | 3,637,827 | 3,372,863 | .93 | 193 | 4,615 |
| Madison | 3,144,160 | 98,141 | 82,556 | ....... | 3,324,857 | 3,006,242 | .90 | 183 | 4,288 |
| Marion | 955,934 | 48,996 | 37,936 | ....... | 1,042,866 | 1,077,333 | 1.03 | 227 | 1,289 |
| Marshall | 378,685 | 21,711 | 18,508 | ....... | 418,904 | 663,842 | 1.58 | 223 | 977 |
| Menard | 383,551 | 30,256 | 16,164 | ....... | 429,971 | 477,547 | 1.11 | 183 | 741 |
| Mercer | 374,154 | 22,656 | 15,355 | ....... | 412,165 | 540,804 | 1.31 | 201 | 750 |
| Montgomery | 673,259 | 31,419 | 15,737 | ....... | 720,415 | 736,011 | 1.02 | 192 | 752 |
| Peoria | 757,758 | 137,607 | 19,498 | ....... | 914,863 | 1,066,034 | 1.17 | 212 | 1,210 |
| Perry | 1,394,176 | 41,566 | 73,974 | ....... | 1,509,716 | 1,408,789 | .93 | 197 | 2,174 |
| Randolph | 591,612 | 27,682 | 14,976 | ....... | 634,270 | 582,580 | .92 | 186 | 875 |
| Rock Island | 13,900 | 47,341 | 1,080 | ....... | 62,321 | 102,333 | 1.64 | 178 | 127 |
| St. Clair | 4,459,839 | 286,926 | 158,046 | ....... | 4,904,811 | 4,253,301 | .87 | 200 | 5,303 |
| Saline | 944,494 | 15,863 | 20,507 | ....... | 980,864 | 997,015 | 1.02 | 171 | 1,385 |
| Sangamon | 4,166,324 | 228,702 | 148,823 | ....... | 4,543,849 | 4,568,143 | 1.01 | 181 | 6,009 |
| Scott | 7,723 | 4,214 | 500 | ....... | 12,437 | 21,797 | 1.75 | 224 | 42 |
| Shelby | 93,225 | 42,443 | 2,589 | ....... | 138,257 | 193,207 | 1.40 | 174 | 269 |
| Stark | 9,166 | 8,420 | 75 | ....... | 17,661 | 29,372 | 1.66 | 200 | 37 |
| Tazewell | 108,691 | 76,599 | 4,592 | ....... | 189,882 | 234,123 | 1.23 | 186 | 296 |
| Vermilion | 2,108,309 | 219,967 | 61,009 | ....... | 2,389,285 | 2,430,586 | 1.02 | 193 | 3,338 |
| Will | 129,788 | 17,792 | 7,375 | ....... | 154,955 | 247,917 | 1.60 | 175 | 527 |
| Williamson | 4,224,650 | 52,878 | 140,459 | ....... | 4,417,987 | 4,341,788 | .98 | 190 | 5,232 |
| Other counties[a] and small mines | 633,994 | 418,056 | 68,510 | ....... | 1,120,560 | 1,640,983 | 1.46 | 208 | 2,074 |
| Total | 37,273,693 | 2,778,141 | 1,418,197 | 10,073 | 41,480,104 | 44,763,062 | 1.08 | 192 | 61,988 |

[a] Bond, Calhoun, Greene, Hancock, Jefferson, Jersey, Kankakee, McLean, Macon, Morgan, Putnam, Schuyler, Warren, Washington, White, and Woodford.

*Coal production of Illinois in 1906 and 1907, by counties, in short tons*—Continued.

## 1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bureau | 1,886,740 | 51,985 | 72,037 | ....... | 2,010,762 | $2,979,557 | $1.48 | 223 | 4,433 |
| Christian | 1,224,132 | 72,012 | 72,015 | ....... | 1,368,159 | 1,451,625 | 1.06 | 194 | 1,654 |
| Clinton | 1,218,343 | 23,682 | 60,366 | ....... | 1,302,391 | 1,232,664 | .95 | 217 | 1,672 |
| Franklin | 1,234,840 | 23,276 | 48,850 | ....... | 1,306,966 | 1,384,744 | 1.06 | 257 | 1,614 |
| Fulton | 1,996,410 | 73,129 | 44,104 | ....... | 2,113,643 | 2,387,615 | 1.13 | 238 | 3,037 |
| Gallatin | 53,118 | 12,644 | 3,698 | 8,505 | 78,055 | 81,445 | 1.04 | 156 | 142 |
| Grundy | 1,222,649 | 53,604 | 51,068 | ....... | 1,327,321 | 1,945,686 | 1.47 | 260 | 2,610 |
| Henry | 82,830 | 63,575 | 3,316 | ....... | 149,721 | 246,057 | 1.64 | 178 | 318 |
| Jackson | 537,546 | 40,817 | 66,970 | ....... | 645,333 | 819,504 | 1.27 | 170 | 956 |
| Knox | ....... | 40,452 | 544 | ....... | 40,996 | 67,864 | 1.66 | 178 | 92 |
| Lasalle | 1,309,045 | 310,730 | 58,215 | ....... | 1,677,990 | 2,660,773 | 1.59 | 237 | 3,250 |
| Livingston | 234,694 | 60,987 | 7,816 | ....... | 303,497 | 424,659 | 1.40 | 248 | 564 |
| Logan | 384,301 | 70,037 | 22,777 | ....... | 477,115 | 506,971 | 1.06 | 195 | 755 |
| McDonough | 21,240 | 10,489 | 470 | ....... | 32,199 | 61,335 | 1.90 | 183 | 88 |
| Macoupin | 4,280,893 | 62,106 | 164,271 | ....... | 4,507,270 | 4,412,539 | .98 | 209 | 4,779 |
| Madison | 3,757,950 | 87,100 | 82,671 | ....... | 3,927,721 | 3,594,068 | .92 | 214 | 4,008 |
| Marion | 1,092,976 | 55,202 | 37,355 | ....... | 1,185,533 | 1,150,493 | .95 | 282 | 1,129 |
| Marshall | 430,990 | 27,764 | 24,042 | ....... | 482,796 | 753,430 | 1.56 | 266 | 973 |
| Menard | 300,442 | 73,711 | 15,765 | ....... | 389,918 | 413,864 | 1.06 | 196 | 693 |
| Mercer | 421,767 | 16,909 | 14,945 | ....... | 453,621 | 620,972 | 1.37 | 222 | 633 |
| Montgomery | 1,221,638 | 37,515 | 29,868 | ....... | 1,289,021 | 1,275,647 | .99 | 180 | 1,545 |
| Peoria | 969,887 | 115,540 | 17,885 | ....... | 1,103,312 | 1,274,774 | 1.16 | 224 | 1,373 |
| Perry | 1,617,168 | 43,301 | 64,000 | ....... | 1 784,469 | 1,678,054 | .94 | 215 | 2,085 |
| Randolph | 780,994 | 28,117 | 15,650 | ....... | 824,761 | 779,745 | .95 | 215 | 960 |
| Rock Island | 11,560 | 39,348 | 2,030 | ....... | 52,938 | 86,479 | 1.63 | 204 | 89 |
| St. Clair | 4,176,080 | 198,694 | 137,105 | ....... | 4,511,879 | 3,865,756 | .86 | 191 | 4,902 |
| Saline | 2,178,240 | 29,251 | 40,351 | ....... | 2,247,842 | 2,217,018 | .99 | 232 | 2,711 |
| Sangamon | 4,699,368 | 296,363 | 164,311 | ....... | 5,160,042 | 5,022,248 | .97 | 191 | 6,428 |
| Scott | 7,700 | 9,399 | 540 | ....... | 17,639 | 28,556 | 1.62 | 223 | 50 |
| Shelby | 115,606 | 32,557 | 7,767 | ....... | 155,930 | 183,897 | 1.18 | 209 | 294 |
| Stark | 3,116 | 22,181 | 600 | ....... | 25,897 | 43,628 | 1 68 | 189 | 72 |
| Tazewell | 144,149 | 87,312 | 4,510 | ....... | 235,971 | 276,127 | 1.17 | 240 | 373 |
| Vermilion | 2,780,846 | 136,887 | 55,520 | ....... | 2,973,253 | 2,997,416 | 1.01 | 248 | 2,877 |
| Will | 163,010 | 14,198 | 6,777 | ....... | 183,985 | 290,558 | 1.58 | 236 | 463 |
| Williamson | 5,469,847 | 60,104 | 167,993 | ....... | 5,697,944 | 5,541,810 | .97 | 214 | 5,600 |
| Other counties[a] and small mines | 818,003 | 394,343 | 58,910 | ....... | 1,271,256 | 1,929,804 | 1.52 | 233 | 2,350 |
| Total | 46,908,118 | 2,775,321 | 1,625,112 | 8,595 | 51,317,146 | 54,687,382 | 1.07 | 218 | 65,581 |

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[a] Bond, Calhoun, Greene, Hancock, Jefferson, Jersey, Kankakee, McLean, Macon, Morgan, Putnam, Schuyler, Wabash, Warren, Washington, White, and Woodford.

In the following table are shown the statistics of production of coal in Illinois, by counties, during the last 5 years, with the increases and decreases in 1907 as compared with 1906:

*Coal production of Illinois, 1903-1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. | |
|---|---|---|---|---|---|---|---|
| Bond | 176,342 | 158,116 | 128,231 | 132,325 | 138,990 | + | 6,665 |
| Bureau | 1,846,642 | 1,821,867 | 1,701,255 | 1,580,085 | 2,010,762 | + | 430,677 |
| Calhoun | 5,300 | 6,500 | 4,727 | 5,045 | 2,850 | − | 2,195 |
| Cass | 1,768 | 810 | ........ | ........ | ........ | ........ | ........ |
| Christian | 1,024,392 | 838,943 | 879,360 | 934,452 | 1,368,159 | + | 433,707 |
| Clinton | 920,391 | 854,719 | 579,281 | 515,796 | 1,302,391 | + | 786,595 |
| Fulton | 1,105,930 | 1,247,215 | 1,529,249 | 1,579,224 | 2,113,643 | + | 534,419 |
| Gallatin | 72,205 | 92,908 | 82,682 | 92,731 | 78,055 | − | 14,676 |
| Greene | 6,639 | 5,986 | 4,435 | 2,206 | 2,310 | + | 104 |
| Grundy | 1,392,427 | 1,334,422 | 1,310,892 | 1,162,019 | 1,327,321 | + | 165,302 |
| Hamilton | 1,200 | ........ | ........ | ........ | ........ | ........ | ........ |
| Hancock | 7,380 | 7,923 | 3,300 | 4,498 | 2,034 | − | 2,464 |
| Henry | 156,870 | 149,259 | 146,905 | 149,188 | 149,721 | + | 533 |
| Jackson | 913,283 | 889,607 | 818,841 | 646,196 | 645,333 | − | 863 |
| Jefferson | 28,245 | 32,788 | 25,925 | 7,600 | 12,000 | + | 4,400 |
| Jersey | ........ | ........ | ........ | 1,397 | 1,162 | − | 235 |
| Johnson | 2,333 | 700 | ........ | ........ | ........ | ........ | ........ |
| Kankakee | 74,226 | ........ | 700 | 39,499 | 26,704 | − | 12,795 |
| Knox | 105,065 | 73,806 | 58,972 | 51,654 | 40,996 | − | 10,658 |
| Lasalle | 1,882,589 | 1,542,518 | 1,772,988 | 1,467,672 | 1,677,990 | + | 210,318 |
| Livingston | 122,773 | 186,638 | 284,984 | 273,831 | 303,497 | + | 29,666 |
| Logan | 469,578 | 350,037 | 445,546 | 435,559 | 477,115 | + | 41,556 |
| McDonough | 28,104 | 26,211 | 19,496 | 43,774 | 32,199 | − | 11,575 |
| McLean | 198,100 | 198,513 | 159,921 | 145,000 | 151,146 | + | 6,146 |
| Macon | 110,000 | 180,851 | 231,235 | 292,884 | 269,766 | − | 23,118 |
| Macoupin | 2,414,499 | 2,170,292 | 3,177,484 | 3,637,827 | 4,507,270 | + | 869,443 |
| Madison | 2,960,496 | 3,341,989 | 3,434,399 | 3,324,857 | 3,927,721 | + | 602,864 |
| Marion | 1,095,952 | 1,010,508 | 1,009,759 | 1,042,866 | 1,185,533 | + | 142,667 |
| Marshall | 479,641 | 467,724 | 499,672 | 418,904 | 482,796 | + | 63,892 |
| Menard | 483,447 | 463,985 | 415,266 | 429,971 | 389,918 | − | 40,053 |
| Mercer | 642,746 | 566,801 | 532,854 | 412,165 | 453,621 | + | 41,456 |
| Montgomery | 458,987 | 499,218 | 598,064 | 720,415 | 1,289,021 | + | 568,606 |
| Morgan | 4,358 | 4,737 | 4,565 | 9,100 | 5,513 | − | 3,587 |
| Peoria | 958,982 | 912,422 | 897,946 | 914,863 | 1,103,312 | + | 188,449 |
| Perry | 1,236,368 | 1,296,962 | 1,298,572 | 1,509,716 | 1,784,469 | + | 274,753 |
| Putnam | ........ | ........ | ........ | 156,928 | 362,858 | + | 205,930 |
| Randolph | 535,896 | 531,465 | 440,991 | 634,270 | 824,761 | + | 190,491 |
| Rock Island | 69,641 | 86,219 | 68,383 | 62,321 | 52,938 | − | 9,383 |
| St. Clair | 3,464,069 | 3,417,632 | 3,329,914 | 4,904,811 | 4,511,879 | − | 392,932 |
| Saline | 433,328 | 568,670 | 675,701 | 980,864 | 2,247,842 | + | 1,266,978 |
| Sangamon | 4,470,962 | 4,219,199 | 4,324,263 | 4,543,849 | 5,160,042 | + | 616,193 |
| Schuyler | 12,927 | 11,673 | 2,880 | 3,090 | 7,553 | + | 4,463 |
| Scott | 24,776 | 19,409 | 13,423 | 12,437 | 17,639 | + | 5,202 |
| Shelby | 108,508 | 129,846 | 104,216 | 138,257 | 155,930 | + | 17,673 |
| Stark | 43,166 | 27,657 | 22,725 | 17,661 | 25,897 | + | 8,236 |
| Tazewell | 253,653 | 194,891 | 231,373 | 189,882 | 235,971 | + | 46,089 |
| Vermilion | 2,955,071 | 2,792,046 | 2,342,238 | 2,389,285 | 2,973,253 | + | 583,968 |
| Warren | 14,989 | 10,784 | 10,354 | 9,520 | 9,139 | − | 381 |
| Washington | 91,766 | 97,069 | 87,913 | 85,812 | 29,000 | − | 56,812 |
| White | ........ | ........ | ........ | 8,000 | 16,453 | + | 8,453 |
| Will | 49,240 | 76,538 | 137,957 | 154,955 | 183,985 | + | 29,030 |
| Williamson | 2,881,653 | 3,395,397 | 4,167,952 | 4,417,987 | 5,697,944 | + | 1,279,957 |
| Woodford | [a] 123,501 | [b] 105,185 | [b] 348,707 | [b] 717,566 | [c] 1,465,708 | + | 748,142 |
| Small mines | 46,711 | 56,405 | 69,777 | 69,290 | 75,036 | + | 5,746 |
| Total | 36,957,104 | 36,475,060 | 38,434,363 | 41,480,104 | 51,317,146 | + | 9,837,042 |
| Total value | $43,196,809 | $39,941,993 | $40,577,592 | $44,763,062 | $54,687,382 | + | $9,924,320 |

[a] Includes production of Wabash County.
[b] Includes production of Franklin County.
[c] Includes production of Franklin and Wabash counties.

The coal fields of Illinois are included in the eastern interior field, which underlies the greater part of Illinois, the southwestern part of Indiana, and part of western Kentucky. Nearly three-fourths of the entire State is underlain by productive coal measures, the total area being estimated at 35,600 square miles. It has been considered the largest coal-bearing area of any one State in the Union, though more definite knowledge may show either North Dakota or Montana to equal or exceed it. The coals of the State as a whole have never been thoroughly studied, so that statements as to the number of coals and their correlation and extent can not be given as yet. The revival of the State geological survey during 1905, and the work already done by it, in cooperation with the United States Geological Survey, give promise of soon placing our knowledge of the coals of the State on a more exact basis. During 1906 the geologic work in the coal fields of Illinois consisted of a survey in the southern Illinois fields, the Eldorado and New Haven quadrangles being completed. A preliminary report on these quadrangles has been printed in Bulletin No. 316, "Contributions to Economic Geology, 1906." During 1906 and 1907 additional work was done to the west of the Eldorado quadrangle and in the region of East St. Louis and around Peoria, in addition to a considerable amount of reconnaissance work, especially along the western and southern border of the coal field. The work already done has served to show that the main coal beds have an extraordinary degree of regularity as compared with the coal series of the Appalachian trough. This is especially true of coals 5, 6, and 7. Thus it has already been demonstrated that coal 5 in southeastern Illinois corresponds to coal 9 of western Kentucky, where apparently it is the principal bed being worked over most of the western Kentucky coal field. The tracing also seems to show that it is the same as coal 5 in southern Indiana, which is the main coal of southern Indiana. In the same way it has been shown that coal No. 7 of southern Illinois is identical with coal No. 11 of western Kentucky. This coal is characterized by a shale parting or "blue band," and other features of the work already completed seem to indicate that it is persistent well up into the middle of the State and possibly beyond. It is now hoped that by the end of 1908 sufficient work will have been completed to at least indicate, if not demonstrate, the correlation of the principal coal beds over the developed portions of the field. The work of Mr. David White on the lower coals has already shown that the earlier correlations can not be relied upon. He has shown that the No. 2 coal of Grundy County is about at the level of the lower Kittanning coal of Pennsylvania, and that coals Nos. 2 to 6 probably fall within the time interval represented in Pennsylvania by the Allegheny formation or lower productive measures. It is not yet clear that the No. 2 coal of McDonough and other counties is at the same horizon as the No. 2 of Grundy County. He has found that the so-called No. 1 coals of different parts of the State occur at distinctly different stratigraphic positions. Thus, he finds the No. 1 coal of Rock Island County belongs in the upper Pottsville, coming probably within the limits of the Connoquenessing sandstone of the Pennsylvania section. The No. 1 coal of Scott County failed to yield good fossil evidence of its age, but the supposed representative of this bed in the deep mine at Litchfield appears to be somewhat younger, probably not older than the Mercer group of Pennsylvania. On the other hand, the No. 1 coal of Hardin County, in the southern part of the State, he finds to come about 100 feet below a coal of lower Pottsville age. These facts are interpreted to mean that during early Pottsville time when, for example, the Pocahontas and New River coals were being deposited, the Illinois coal field was restricted to a small part of the present basin, that changing conditions allowed the gradual spread of the coal-forming conditions, but that the present limits of the field were not reached until late Pottsville time.

The coal field in Illinois occupies a basin. In the center the lower coals are at least 1,000 feet deep, and the outcropping rocks belong to the upper or nonproductive coal measures. Around the edge of the basin the productive measures outcrop in a broad belt. Except along the southern edge and part of the western edge of the field, the coal beds and other rocks lie with such slight dips as to be practically level. A striking exception to this is the sharp fold that enters the coal field near La Salle and extends to the southeast. This appears to be an anticline in which the western limb is very sharply depressed, carrying the coals several hundred feet lower than they are immediately east of the axis of the fold. West of this fold, in the northwest part of the field, the dip is eastward about 7 feet to the mile. Around the southwest and southern margins the dip becomes much steeper. In the southeast part of the State the rocks are disturbed by faulting and the flow of igneous rocks. A notable fault or break enters the State from Kentucky at Shawneetown.

Beginning at the northeast, in the Danville field, two beds of coal are worked, each from 5 to 7 feet thick and 80 feet apart. The coals have been considered the equivalent of Nos. 6 and 7. No. 6 has been applied to what is locally known as the Grape Creek bed, and No. 7 to the Danville bed. The coals are reached at depths of from 0 to 200 feet.

Northwest of Danville are the Wilmington and Streator fields. In the first the Wilmington coal, sometimes called No. 2, is worked. The coal is thin and irregular, averaging only about 3 feet, though increasing to 6 feet in places. This coal underlies part of Will County, two-thirds of Grundy County, the northeastern part of Kankakee County, and parts of Livingston and La Salle counties. It lies at depths of from 0 to 550 feet.

In the Streator field in La Salle, Livingston, and Kankakee counties the Streator coal, which has been called the No. 7, is worked. It has a thickness of from 4 to 8 feet, with an average of about 5 feet, and is worked at depths of from 65 to 200 feet east of the line of the La Salle fold. West of that fold the worked coals are from 375 to 500 feet below the surface. They are from 3 to 5 feet in thickness, and have been correlated as beds Nos. 2 to 5.

Westward from La Salle the coals correlated as Nos. 2, 5, and 7 have been worked. The so-called No. 5 lies 150 feet above the No. 2, and No. 7, 50 feet still higher. The coals range in thickness from 2½ to 4 feet, and are worked at depths of from 0 to 555 feet. The Kewanee coal of Henry County, correlated as coal No. 6, is 4 feet thick, and less than 100 feet deep, and in Stark County it is from 2½ to 6 feet thick, at depths of from 0 to 130 feet. A coal correlated as No. 4, 4 to 6 feet thick, underlies most of Stark County and outcrops along the river bluffs in Peoria County. Coal called No. 2, 4 feet thick, is reported under the river bottoms at depths of 120 feet, and No. 1, 3 feet thick, at 235 feet. In Rock Island and Mercer counties the worked coals are shallow and from 2 to 4 feet thick.

West and southwest of Peoria coals called Nos. 2, 4, 5, 6, and 7 are worked, lying at depths of less than 200 feet, and varying from 2 to 6 feet in thickness. The bed principally worked is correlated as coal

No. 4. Farther west, along the Mississippi Valley, the lower coals, with thicknesses of from 2 to 3 feet, are worked at depths of usually less than 100 feet. The lower coals continue southward with a thickness of 3 to 4 feet. The higher coals outcrop in the western part of the fourth district, in Tazewell and Menard counties, where coals called Nos. 4 and 5, with a thickness of from 4 to 5 feet, outcrop at depths of less than 200 feet. From the latitude of Springfield southward the outcrop of the productive measures becomes comparatively narrow, the eastward dip becoming steeper, so that each of the various coals is near the surface within a comparatively narrow belt. The coals are mined at slight depths, usually less than 100 feet. In the river counties they range from 2 to 5 feet in thickness, but are generally less than 3 feet. The bulk of the worked coal from Sangamon and Macoupin counties is taken from under the outcrop of the upper coal measures. A few mines in these counties, however, reach the so-called coal No. 5 at depths of from 50 to 200 feet, where it has a thickness of from 5 to 7 feet. In Madison and St. Clair counties the main coal worked is known as the Belleville bed. A short distance above it is another bed of almost, if not quite, equal thickness. These coals have a thickness ranging from 5½ to 7½ feet, with an average of over 6 feet. They are mined at depths varying from 50 to 300 feet, most of the large mines having a depth of from 100 to 200 feet. They underlie all the uplands of Madison County, and three-fourths of St. Clair County. The area within which the productive measures come to the surface continues around the south end of the field, with a width of from 20 to 30 miles. Along its southern edge only the lower coals are exposed, usually with a thickness of less than 3 feet. Within the northern portion of this strip coals that have been correlated as Nos. 4, 5, 6, and 7 are workable at depths of less than 300 feet. Of these No. 5 varies from 5 to 7 feet in thickness where worked; No. 6 from 8 feet down; No. 7 from 10 feet down. Coal No. 6, or the Duquoin coal, averages about 6 feet in the mines. It is extensively mined in Randolph and Perry counties at depths of up to 200 feet. A 9-foot bed is worked at St. Johns at a depth of 300 feet. At Coulterville, in Randolph County, a 6-foot bed is found at 370 feet. Coal No. 7 varies from about 4 feet in Gallatin County to an average of 9 feet in many of the mines of Williamson County, where it is known as the Carterville bed. The coal underlies the north half of this county at depths up to 150 feet. Coal No. 5 lies 100 to 150 feet deeper. In Jackson County the Big Muddy coal, probably coal No. 2, is from 5 to 7 feet thick, with an average thickness in the mines of over 6 feet. In depth it varies from 20 to 166 feet. In Johnson County a 3-foot, 4-inch surface coal is mined. In Saline County coal is found at 144 feet; at Harrisburg with a thickness of 6 to 7 feet. No. 7, 3 to 5 feet thick, outcrops over the county. In Gallatin County the coals worked range from 4 feet to 4 feet 10 inches at depths of less than 100 feet. Within the area of outcrop of the upper or barren coal measures, shafts have been sunk to the coals in the underlying productive measures. The coals range in thickness from 3 to 8 feet and up to 11 feet, and in depth up to 1,004 feet. Many of the mines have a depth of from 600 to 900 feet. The principal coals are supposed to lie at the horizons of Nos. 5, 6, and 7. In the eastern part of the State is a large area in which at present is no mining, but in which the evidence indicates that it is only a question of time until this will prove as valuable a part of the field as any other.

Recent analyses of the Illinois coals showed them to contain from 6 to 12 per cent of moisture; from 6 to 12 per cent of ash; from 33 to 42 per cent of volatile matter; from 34 to 50 per cent of fixed carbon; from 1 to 4½ per cent of sulphur. The No. 7 coal of Williamson County will run even better—3 to 6 per cent of moisture; 4 to 9 per cent of ash; 30 to 40 per cent of volatile matter; 50 to 56 per cent of fixed carbon; and 0.8 to 2 per cent sulphur. And, on the other hand, the slack coal from many of the mines runs from 20 to 25 per cent of ash, with corresponding decrease in the valuable constituents.

Most of the coal of the State is reached by shafts, which, as a rule, are well equipped with self-dumping cages where large cars are used, or with double-deck cages, hoisting two cars at a time, where the cars are small. The shafts range in depth from 80 feet to over 1,000 feet. While the room and pillar method largely prevails, many of the thinner coals are worked by the long-wall method, especially in the mines on the thinner lower coals. In the long-wall field the rock refuse hoisted amounts to 10 to 15 per cent of the coal hoisted. Machine mining has not made the progress in this State that it has in some others on account of the small mining machine differential. The majority of the mines are fairly dry, requiring but little pumping. Mine cars carry from 1 ton to 3½ tons, and as the dip is usually low and haulage easy, mechanical haulage has been introduced but slowly, tail rope and electric motors being used. While a majority of the hoists are second motion, all of the larger new mines use first motion engines. Tipples are well built, most of the new ones being of steel. They are usually well equipped with shaking screens, and at many of the mines the screenings are washed and rescreened. As a rule the coal is weighed run of mine. Illinois coal goes to Illinois, eastern Iowa, southern Wisconsin, and Minnesota, and southeastern Missouri. Chicago is naturally the largest market.

Probably the earliest mention of coal in the United States is contained in the journal of Father Hennepin, a French missionary, who as early as 1679 reported a "cole" mine on the Illinois River, above Fort Crevecœur, near the site of the present city of Ottawa. Father Hennepin marked the location of the occurrence on the map which illustrates his journal. It is also probable that, outside of anthracite mining in Pennsylvania and the operations in the Richmond basin of Virginia, Illinois holds the record for priority of production. The earliest statement that we have in regard to actual mining in Illinois is that coal was produced in Jackson County in 1810 from a point on the Big Muddy River. A flatboat was loaded with coal at this place and shipped to New Orleans, but the quantity is not stated. Again, it is reported that in 1832 several boat loads were sent from the same vicinity to the same market. Another record is found stating that 150,000 bushels (or 6,000 tons) of coal were mined in 1833 in St. Clair County and hauled by wagons to St. Louis. From 1840 to 1860 the bureau of statistics of the State is without any reliable data in regard to the coal-mining industry, although some scattering statistics are found in the geological reports published by the State government. The production of coal in Illinois since 1833 will be found in the table on a preceding page giving the history of coal production in the United States from the earliest times to the close of 1907.

According to Mr. Campbell's estimate[a] the original coal supply of Illinois when mining began was 240,000,000,000 short tons, all bituminous and contained within a total area of 35,600 square miles. The total production of the State at the close of 1907, as far as records are obtainable, amounted to 645,868,309 tons, which, with a half-ton wasted for every ton mined, is equivalent to a total exhaustion of 968,000,000 short tons, from which it appears that the exhaustion to the close of 1907 was about 0.4 of 1 per cent of the total estimated supply. The production of coal in Illinois in 1907 was about 8 per cent of the aggregate production to the close of that year, and the quantity of coal estimated as still remaining in the ground at the close of 1907 is 4,664 times the production of that year, or about 2,500 times the exhaustion represented by that production.

## INDIANA.

Total production in 1907, 13,985,713 short tons; spot value, $15,114,300.

Indiana continues to rank sixth among the coal-producing States, although in 1907 it closely rivaled Alabama as the fifth State in coal-producing importance. Indiana's coal production has increased with marked rapidity during the last decade. The developments in Greene and Sullivan counties have been conspicuous factors in this increasing production. In 1907 the coal production of Indiana showed an increase over the preceding year of 1,893,153 short tons, or 15.66 per cent, in quantity, and of $1,998,039, or 15.23 per cent, in value. Alabama's production in 1907 over 1906 increased only 8.72 per cent in quantity and 5.09 per cent in value, and reached a total of 14,250,454 short tons, or about 265,000 tons more than that of Indiana. Indiana's increase in 1907 over 1906 exceeded by 750,000 tons the increase in Alabama's production, and a corresponding gain in 1908 would give Indiana the lead over Alabama. The counties in Indiana in which the principal increases were shown in 1907 over 1906 were Vigo, 527,284 tons; Sullivan, 481,993 tons; Greene, 466,458 tons; Clay, 165,279 tons; Vermilion, 99,625 tons; and Warrick, 120,507 tons. The first five of these are the five most important producing counties in the State, while Warrick County had of the six the largest percentage of increase.

In 1906 the mining operations in Indiana, as in most of the coal-producing States, were considerably interfered with by the suspension of work by the miners, pending a settlement of the wage agreements, 15,875 men, out of a total of 20,970 men employed in the State, having been idle for an average of 63 days, while, notwithstanding this interruption, the production in 1906 showed a slight gain over 1905. In 1907 the loss of time by reason of labor disaffection in Indiana was negligible, there being but 3,176 men on strike, and the average idleness amounting to only 13 days for each man. In the report for 1906 it was stated that had it not been for the time lost by the suspension, and other things being equal, the production of Indiana in that year would have amounted to 15,000,000 tons, and this figure would probably have been closely approached in 1907 had it not been for the effects of the monetary disturbances in the latter part of the year and a shortage of railroad cars during the first 9 months. It has been estimated that the deficiency in car supply caused a shortage in production of 600,000 tons and that a further reduction of 500,000 tons was caused by the financial depression. But for these two factors the tonnage would have exceeded the 15,000,000-ton estimate of possible production. The complaint of deficient car service was said to have been made against practically all the railroads in the State except the Southern Railway, on which, according to the operators along that line, the service was uniformly good at all periods of the year. Freight rates, in general, have been equalized and have improved from the operators' point of view, this having been due to a considerable extent to the efforts of the Indiana railroad commission.

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[a] Coal fields of the United States, by Marius R. Campbell, U. S. Geol. Survey, 1908.

The total number of men employed in the coal mines of Indiana in 1907 was 21,022, who worked an average of 197 days, against 20,970 men, who worked an average of 175 days in 1906. The average production for each man employed in 1907 was 665 short tons, against 576.7 tons in 1906 and 469.7 tons in 1905. The average tonnage per man per day was 3.38 in 1907, against 3.3 in 1906 and 3.11 in 1905. The increased productive capacity per man employed was, in part, due to the increased use of mining machinery, the statistics for 1907 showing a total of 513 mining machines in use, with a total machine-mined product of 5,310,607 short tons, against 471 machines in use in 1906, with a machine-mined product of 4,251,740 short tons. In 1906 the percentage of the machine-mined product to the total was 35.16, while in 1907 it was 37.97. Practically all of the important mines in the State are operated on an 8-hour basis, mines employing 18,323 men out of a total of 21,022 reporting 8 hours as the length of the working day. The mines working 9 or 10 hours are practically local, or comparatively unimportant producers.

According to the report of Mr. James Epperson, State mine inspector, the number of men killed in the coal mines of Indiana was 53, while 451 were injured. Of the 53 men killed, 2 met death through gas and dust explosions, 18 through explosions of powder and windy shots, and 16 through falls of roof or coal, and 17 deaths were attributed to other causes. Of the 451 men injured, 153 were hurt by falls of roof or coal, 33 by powder explosions and windy shots, and 16 by gas and dust explosions, while 249 injuries were attributed to other causes.

One company reported, in 1907, having washed a part of its production. The washery contains 4 jigs and washed in 1907 23,825 tons of coal, yielding 21,659 tons of cleaned coal and 2,166 tons of refuse.

The statistics of production of coal in Indiana in 1906 and 1907, by counties, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Indiana in 1906 and 1907, by counties, in short tons.*

**1906.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Clay | 990,156 | 57,740 | 53,332 | 1,101,228 | $1,486,418 | $1.35 | 193 | 2,454 |
| Daviess | 90,899 | 41,940 | 3,146 | 135,985 | 178,772 | 1.31 | 184 | 274 |
| Dubois and Martin | 200 | 14,400 | 100 | 14,700 | 19,875 | 1.35 | 300 | 10 |
| Fountain and Warren | 75,664 | 6,754 | 2,051 | 84,469 | 104,342 | 1.24 | 209 | 119 |
| Gibson | 123,694 | 15,350 | 3,400 | 142,444 | 168,354 | 1.18 | 203 | 224 |
| Greene | 2,197,906 | 37,956 | 71,624 | 2,307,486 | 2,474,681 | 1.72 | 170 | 3,938 |
| Knox | 284,370 | 38,464 | 10,999 | 333,833 | 382,253 | 1.15 | 184 | 489 |
| Parke | 654,100 | 13,690 | 39,237 | 707,027 | 969,090 | 1.37 | 197 | 1,347 |
| Perry | 9,821 | 3,228 | 212 | 13,261 | 18,991 | 1.43 | 233 | 33 |
| Pike | 462,365 | 27,100 | 8,492 | 497,957 | 556,184 | 1.12 | 180 | 946 |
| Spencer | ........ | 19,256 | ........ | 19,256 | 26,529 | 1.38 | 143 | 63 |
| Sullivan | 2,308,103 | 51,863 | 55,881 | 2,415,847 | 2,551,670 | 1.06 | 143 | 4,515 |
| Vanderburg | 152,794 | 142,264 | 7,861 | 302,919 | 337,504 | 1.11 | 243 | 437 |
| Vermillion | 1,314,703 | 7,202 | 20,573 | 1,342,478 | 1,115,196 | .83 | 164 | 1,975 |
| Vigo | 2,038,472 | 105,240 | 53,747 | 2,197,459 | 2,268,750 | 1.03 | 193 | 3,589 |
| Warrick | 403,506 | 36,769 | 7,720 | 447,995 | 426,478 | .95 | 166 | 557 |
| Small mines | ........ | 28,216 | ........ | 28,216 | 31,084 | 1.10 | ........ | ........ |
| Total | 11,106,753 | 647,432 | 338,375 | 12,092,560 | 13,116,261 | 1.08 | 175 | 20,970 |

**1907.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Clay | 1,163,548 | 62,396 | 40,563 | 1,266,507 | $1,667,050 | $1.32 | 206 | 2,570 |
| Daviess | 77,127 | 39,802 | 4,067 | 120,996 | 181,557 | 1.50 | 192 | 244 |
| Dubois and Martin | ........ | 8,460 | ........ | 8,460 | 12,074 | 1.43 | 99 | 18 |
| Fountain and Warren | 35,132 | 5,938 | 200 | 41,270 | 54,365 | 1.32 | 196 | 93 |
| Gibson | 145,539 | 56,260 | 5,673 | 207,472 | 252,717 | 1.22 | 248 | 347 |
| Greene | 2,663,246 | 44,035 | 66,663 | 2,773,944 | 2,951,060 | 1.06 | 184 | 4,244 |
| Knox | 341,135 | 23,585 | 9,379 | 374,099 | 376,142 | 1.01 | 169 | 556 |
| Parke | 613,105 | 18,206 | 24,001 | 655,312 | 918,646 | 1.40 | 216 | 1,322 |
| Perry | 8,977 | 8,748 | 240 | 17,965 | 28,950 | 1.61 | 197 | 39 |
| Pike | 469,029 | 38,316 | 9,073 | 516,418 | 543,912 | 1.05 | 170 | 933 |
| Spencer | 1,000 | 24,916 | ........ | 25,916 | 36,870 | 1.42 | 196 | 44 |
| Sullivan | 2,806,593 | 33,228 | 58,019 | 2,897,840 | 2,949,398 | 1.02 | 169 | 4,084 |
| Vanderburg | 90,964 | 217,291 | 9,116 | 317,371 | 365,996 | 1.15 | 235 | 466 |
| Vermillion | 1,400,738 | 13,300 | 28,065 | 1,442,103 | 1,290,081 | .89 | 207 | 1,857 |
| Vigo | 2,569,049 | 83,803 | 71,891 | 2,724,743 | 2,903,730 | 1.07 | 230 | 3,564 |
| Warrick | 502,755 | 50,002 | 15,765 | 568,522 | 547,300 | .96 | 208 | 641 |
| Small mines | ........ | 26,775 | ........ | 26,775 | 34,452 | 1.29 | ........ | ........ |
| Total | 12,887,937 | 755,061 | 342,715 | 13,985,713 | 15,114,300 | 1.08 | 197 | 21,022 |

In the following table is shown the production of coal in Indiana, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906:

*Coal production of Indiana, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Clay | 1,242,958 | 960,094 | 781,574 | 1,101,228 | 1,266,507 | + 165,279 |
| Daviess | 183,692 | 143,877 | 101,429 | 135,985 | 120,996 | − 14,989 |
| Dubois | [a]8,546 | [a]13,833 | [a]7,200 | [a]14,700 | [a]8,460 | − 6,240 |
| Fountain | 18,660 | 41,452 | [b]79,995 | [b]84,469 | [b]41,270 | − 43,199 |
| Gibson | 81,946 | 98,257 | 99,322 | 142,444 | 207,472 | + 65,028 |
| Greene | 2,303,512 | 2,440,420 | 2,458,665 | 2,307,486 | 2,773,944 | + 466,458 |
| Knox | 177,046 | 173,406 | 293,480 | 333,833 | 374,099 | + 40,266 |
| Parke | 989,983 | 924,001 | 750,314 | 707,027 | 655,312 | − 51,715 |
| Perry | 24,941 | 26,218 | 17,018 | 13,261 | 17,965 | + 4,704 |
| Pike | 505,564 | 408,391 | 452,396 | 497,957 | 516,418 | + 18,461 |
| Spencer | 19,948 | 17,511 | 16,935 | 19,256 | 25,916 | + 6,660 |
| Sullivan | 1,788,358 | 2,061,212 | 2,571,818 | 2,415,847 | 2,897,840 | + 481,993 |
| Vanderburg | 241,088 | 258,254 | 300,112 | 302,919 | 317,371 | + 14,452 |
| Vermilion | 915,171 | 1,068,427 | 1,302,667 | 1,342,478 | 1,442,103 | + 99,625 |
| Vigo | 1,826,393 | 1,756,250 | 2,189,603 | 2,197,459 | 2,724,743 | + 527,284 |
| Warren | 5,250 | 6,545 | | | | |
| Warrick | 435,797 | 416,311 | 447,576 | 447,995 | 568,522 | + 120,507 |
| Small mines | 25,839 | 27,730 | 25,148 | 28,216 | 26,775 | − 1,441 |
| Total | 10,794,692 | 10,842,189 | 11,895,252 | 12,092,560 | 13,985,713 | + 1,893,153 |
| Total value | $13,244,817 | $12,004,300 | $12,492,255 | $13,116,261 | $15,114,300 | +$1,998,039 |

[a] Includes Martin County.

[b] Includes Warren County.

The eastern edge of the eastern interior, or central, coal field underlies the southwest portion of Indiana, the total area in the State embracing 6,500 square miles and underlying 26 different counties, in 18 of which at present coal is produced on a commercial scale. All of the coal produced in Indiana is classed as bituminous coal. The coal along the eastern edge of the field is known as block or semiblock coal. It is very pure, dry, noncoking coal, and derives its name from the almost perfectly rectangular blocks into which it breaks, because of the pronounced cleavage planes which intersect each other nearly at right angles. The rest of the coal, distinguished locally as "bituminous," is classed as coking and gas coal, though it is not of sufficiently high grade to compete for those uses with the high-grade coking and gas coals from the East. As a steam coal it competes successfully with the Appalachian coals where the freight rates are slightly in its favor. Cannel coal is successfully mined at one or two points.

Coal has been found at at least 20 different horizons, and as many as 17 beds have been passed through in a single drilling in a vertical distance of 800 feet. Most of these are thin, but beds of sufficient thickness to be worked are found at 8 different horizons. At present the commercial coal is coming from 6 of these. The lower coals which outcrop along the outer or eastern edge of the basin, the block coals mentioned above, occur in basins of from a few acres up, the coal being often 5 feet in the center of the basin and thinning to a few inches on the edges. The basins are usually connected and occur at distinct horizons, so that at any horizon the coals of the different basins show the same characteristics of roof, floor, parting, and character of coal. The coal in the block-coal field runs from 2 to 5 feet in thickness, averaging about 3 feet 6 inches. The upper or so-called "bituminous" beds show remarkable persistency over large areas. In many cases the different beds have striking peculiarities that differentiate them at once and allow of tracing them with certainty over several thousand square miles. The horizons of the principal coals are believed to have been continuously traced entirely across the portion of the field in this State. The upper coals range from 3 to 10 feet in thickness, and the majority of the mines have coal 5 or more feet in thickness, over 26 of the large mines having coal 7 or more feet thick. Over 90 per cent of the coals now mined have a clay floor, and a still larger percentage have a shale roof. Taking the coal field as a whole, there are considerable areas which do not contain any workable coal; on the other hand, a large part of the field is underlain by more than one workable bed. A number of mines work as high as 3 beds, sometimes all at once, sometimes in succession. Parts of the field are underlain by about 20 feet of workable coal.

Nearly all of the commercial mines reach the coal by shafts at depths of from 50 to 450 feet; though there are a few slope mines and still fewer drift mines. As a whole the mines are well equipped with modern machinery, including mining machines (in which the electric chain machines are in the large majority), electric motors, self-dumping cages, shaking screens, box-car loaders, etc.

The United States census for 1840 reports a production of coal in Indiana for that year of 9,682 tons. The census for 1850 did not include any investigation of the mining industry, and the next official statistics are for the year 1860, when the census reported a production of 101,280 short tons. Ten years later the census for 1870 reported a production of 437,870 short tons. In 1880 the production had grown to 1,454,327 short tons, and in 1890 it amounted to 3,305,737 short tons. In the closing year of the last century the production had nearly doubled again, amounting to 6,484,086 short tons, and this output was again nearly doubled by the tonnage of 1907.

The statistics of production of coal in Indiana since 1840 will be found in the table on a preceding page, giving the statistical history of the coal production of the United States from the earliest times to the close of 1907.

Mr. Campbell's estimate regarding the coal fields of Indiana placed the original supply at 44,169,000,000 short tons. The aggregate production of coal in Indiana, to the close of 1907, amounted to 159,440,390 short tons, of which 13,985,713 tons, or practically 9 per cent, were produced in 1907. Mr. Campbell estimates the exhaustion represented by this production at 239,000,000 tons, or 0.54 of 1 per cent of the estimated original supply. Upon these estimates the quantity of coal remaining in the ground in Indiana at the close of 1907 was about 3,000 times the production of that year, and 2,000 times the exhaustion represented by that production.

## IOWA.

Total production in 1907, 7,574,322 short tons; spot value, $12,258,012.

The monetary disturbances of the latter part of 1907 affected mining conditions in Iowa but little, the chief trouble occurring when the miners at some places refused to accept checks and clearing-house certificates in payment of wages, which resulted in some insignificant strikes and the shutting down of some of the mines for three or four days. Outside of this, there were no labor troubles in the State during the year, and the total number of men on strike at any time was 1,621, and the average number of days idle was 5.

The car supply throughout the year was generally satisfactory, and freight rates were improved by recent legislation. An exception to the general satisfactory condition in connection with the car supply was reported from the southeastern district of the State, particularly during August, September, and October, when, according to report, the car supply in that region was less than 40 per cent of the mine requirements. After November 1 there was an abundant car supply on all lines.

As compared with 1906, the coal production of Iowa in 1907 showed an increase of 308,098 short tons, or 4.24 per cent in quantity, with an increase in value of $638,557, or 5.5 per cent. The coal production of the State for the fiscal year ended June 30, 1907, as reported by Mr. Edward Sweeney, the inspector of the third mining district of Iowa, was 7,545,525 short tons, which was slightly less than the production reported to the United States Geological Survey for the calendar year, but shows a gain of 279,301 short tons over the production reported in 1906, indicating that most of the increase in 1907 took place during the first six months of the year.

The comparatively insignificant effect of the financial depression on the coal production of Iowa is attributed to the fact that the output is not largely consumed by industrial operations outside of the very considerable tonnage used by the railroads traversing the State. The output goes principally to domestic consumers.

One of the conditions which it is claimed has adversely affected the coal production of Iowa, especially in the southeastern district, as compared with competing districts in other States, is the method of fixing the mining rate to Danville, Ill., as a basis point. The first interstate agreement between the operators and the miners, covering the competitive fields of Illinois, Indiana, and Ohio, was made about 10 years ago, and the agreement between the Iowa operators and the miners was based thereon. This agreement, as stated, fixed the price of mining in the competitive States with Danville, Ill., as the basis point, the freight rates to the competitive markets charged at that time being a part of the consideration in the adjustment of the wage scale. Under these conditions Iowa coals competed with the coals from Indiana and Illinois in the Iowa markets, but subsequently freight rates from those States into Iowa territory have at various times been reduced without corresponding reductions in the freight rates from Iowa mines to the same markets. The rates are promulgated by the State board of railroad commissioners and are the same to-day as 20 years ago. In order to show the effect of these unfavorable freight rates upon Iowa's coal production, attention is called to the fact that in the last 10 years the output of Illinois has increased from 20,000,000 to over 51,000,000 tons, or 155 per cent. The Iowa production has shown an increase of 2,962,457 short tons, or 64 per cent, from 4,611,865 tons in 1897 to 7,574,322 tons in 1907.

The number of men employed in the coal mines of Iowa in 1907 was 15,585, who worked an average of 230 days, as against 15,260 men for an average of 224 days in 1906 and 15,113 men for 209 days in 1905. The average production per man in the last three years has been 449.9 in 1905, 476.2 in 1906, and 486 in 1907. The average tonnage per day for each man in the three years was, respectively, 2.15, 2.13, and 2.11. A part of the decreased daily production in 1907 was probably due to the falling off in the quantity of coal mined by machinery. In 1906 34 machines were reported in use, with a total of 193,666 tons of machine-mined coal. In 1907 there were 33 machines reported in use, and the machine-mined product decreased to 108,022 tons.

As in the other coal-mining States in which operations are carried on under agreement with the mine-workers' union, the mines of Iowa were for the greater part worked on the basis of the 8-hour day. In 1907, 15,171 out of a total of 15,585 men were reported as working 8 hours. The mines in which any other length of working day is reported are comparatively unimportant operations.

According to Messrs. John Verner, R. T. Rhys, and Edward Sweeney, inspectors for the three mining districts into which the coal fields of Iowa are divided, the casualty record of 1907 consisted of 41 men killed and 68 injured. Of the total number of fatalities, only 1 was due to the explosion of dust or gas; 3 were due to explosions of powder or misplaced shots, and 29 were due to falls of roof or coal. Two men were killed by being caught by cars or motors, 4 met death in shaft accidents, and 2 deaths were attributed to miscellaneous causes. The death rate per 1,000 employees was 2.63, and the number of tons mined for each life lost was 184,740.

The statistics of coal production in Iowa in 1906 and 1907, by counties, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Iowa in 1906 and 1907, by counties, in short tons.*

**1906.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Adams | 200 | 11,488 | 36 | 11,724 | $27,154 | $2.32 | 150 | 67 |
| Appanoose | 1,039,610 | 47,842 | 14,143 | 1,101,595 | 2,112,169 | 1.92 | 199 | 3,254 |
| Boone | 213,677 | 14,767 | 4,666 | 233,110 | 436,497 | 1.87 | 179 | 844 |
| Greene | 2,400 | 16,306 | 1,110 | 19,816 | 40,377 | 2.04 | 178 | 62 |
| Guthrie | 2,128 | 9,895 | 40 | 12,063 | 31,307 | 2.60 | 140 | 68 |
| Jasper | 353,914 | 16,193 | 18,475 | 388,582 | 627,653 | 1.62 | 224 | 835 |
| Keokuk | 1,000 | 15,504 | 640 | 17,144 | 32,067 | 1.87 | 174 | 46 |
| Mahaska | 551,392 | 31,167 | 19,928 | 602,487 | 876,041 | 1.45 | 229 | 1,126 |
| Marion | 339,445 | 22,894 | 10,411 | 372,750 | 530,847 | 1.42 | 208 | 640 |
| Monroe | 2,369,445 | 37,458 | 51,570 | 2,458,473 | 3,345,264 | 1.36 | 248 | 3,712 |
| Polk | 1,095,573 | 238,410 | 35,523 | 1,369,506 | 2,363,393 | 1.73 | 252 | 2,793 |
| Taylor | 12,255 | 6,777 | 20 | 19,052 | 40,909 | 2.15 | 177 | 82 |
| Van Buren | 9,825 | 2,209 | 103 | 12,137 | 24,418 | 2.01 | 174 | 39 |
| Wapello | 166,757 | 72,443 | 4,056 | 243,256 | 378,072 | 1.55 | 198 | 578 |
| Wayne | 117,850 | 18,744 | 100 | 136,694 | 260,178 | 1.90 | 214 | 433 |
| Webster | 98,118 | 8,868 | 2,536 | 109,522 | 218,180 | 1.99 | 224 | 323 |
| Other counties[a] and small mines | 87,619 | 62,687 | 8,007 | 158,313 | 274,929 | 1.74 | 209 | 358 |
| Total | 6,461,208 | 633,652 | 171,364 | 7,266,224 | 11,619,455 | 1.60 | 224 | 15,260 |

[a] Dallas, Jefferson, Lucas, Page, Scott, and Warren.

*Coal production of Iowa in 1906 and 1907, by counties, in short tons*—Continued.

### 1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Adams | 210 | 14,090 | 43 | 14,343 | $33,628 | $2.30 | 138 | 45 |
| Appanoose | 1,052,972 | 60,067 | 10,370 | 1,123,409 | 2,153,205 | 1.93 | 203 | 3,546 |
| Boone | 183,495 | 17,205 | 7,450 | 208,150 | 415,136 | 1.99 | 188 | 805 |
| Greene | 2,707 | 12,723 | 859 | 16,289 | 33,645 | 2.07 | 159 | 52 |
| Guthrie | ........... | 13,806 | 34 | 13,840 | 36,161 | 2.61 | 172 | 60 |
| Jasper | 370,114 | 7,503 | 19,680 | 397,297 | 641,386 | 1.61 | 242 | 741 |
| Keokuk | ........... | 27,176 | 540 | 27,716 | 63,603 | 2.29 | 234 | 30 |
| Mahaska | 702,892 | 33,810 | 21,076 | 757,778 | 1,107,695 | 1.46 | 224 | 1,436 |
| Marion | 310,496 | 27,682 | 8,821 | 346,999 | 489,968 | 1.41 | 229 | 500 |
| Monroe | 2,358,681 | 53,278 | 64,062 | 2,476,021 | 3,432,799 | 1.39 | 263 | 3,661 |
| Polk | 1,224,780 | 199,492 | 35,931 | 1,460,203 | 2,529,838 | 1.73 | 238 | 2,931 |
| Taylor | 13,871 | 5,761 | 60 | 19,692 | 46,481 | 2.36 | 227 | 76 |
| Van Buren | 12,542 | 2,775 | 57 | 15,374 | 30,913 | 2.01 | 202 | 37 |
| Wapello | 179,781 | 75,546 | 3,324 | 258,651 | 410,298 | 1.59 | 237 | 488 |
| Wayne | 134,586 | 12,315 | ........... | 146,901 | 286,949 | 1.95 | 255 | 438 |
| Webster | 67,289 | 11,028 | 1,958 | 80,275 | 167,547 | 2.09 | 230 | 227 |
| Other counties[a] and small mines | 159,728 | 43,514 | 8,142 | 211,384 | 378,760 | 1.79 | 197 | 512 |
| Total | 6,774,144 | 617,771 | 182,407 | 7,574,322 | 12,258,012 | 1.62 | 230 | 15,585 |

[a] Dallas, Davis, Jefferson, Lucas, Page, Scott, and Warren.

The production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, is shown in the following table:

*Coal production of Iowa, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Adams | 22,570 | 12,970 | 13,071 | 11,724 | 14,343 | + 2,619 |
| Appanoose | 893,021 | 872,920 | 884,248 | 1,101,595 | 1,123,409 | + 21,814 |
| Boone | 291,321 | 285,157 | 202,659 | 233,110 | 208,150 | − 24,960 |
| Dallas | 15,467 | 13,086 | 5,000 | 5,522 | 70,042 | + 64,520 |
| Davis | 3,160 | ........... | ........... | ........... | 1,300 | + 1,300 |
| Greene | 14,971 | 27,704 | 20,058 | 19,816 | 16,289 | − 3,527 |
| Jasper | 270,804 | 258,098 | 306,164 | 388,582 | 397,297 | + 8,715 |
| Jefferson | 6,844 | 9,810 | 3,379 | 3,744 | 4,000 | + 256 |
| Keokuk | 62,875 | 41,512 | 16,460 | 17,144 | 27,716 | + 10,572 |
| Lucas | 295,554 | 189,895 | 147,093 | 97,147 | 105,536 | + 8,389 |
| Mahaska | 698,166 | 675,113 | 714,945 | 602,487 | 757,778 | + 155,291 |
| Marion | 324,859 | 314,908 | 338,812 | 372,750 | 346,999 | − 25,751 |
| Monroe | 1,768,054 | 1,987,450 | 2,225,677 | 2,458,473 | 2,476,021 | + 17,548 |
| Page | 16,343 | 18,302 | 14,013 | 11,235 | 14,338 | + 3,103 |
| Polk | 1,032,164 | 1,130,668 | 1,210,320 | 1,369,506 | 1,460,203 | + 90,697 |
| Scott | 12,653 | 9,930 | 6,222 | 24,778 | 1,047 | − 23,731 |
| Taylor | 16,933 | 16,273 | 22,345 | 19,052 | 19,692 | + 640 |
| Van Buren | 13,561 | 8,005 | 6,192 | 12,137 | 15,374 | + 3,237 |
| Wapello | 382,398 | 379,560 | 303,360 | 243,256 | 258,651 | + 15,395 |
| Warren | 12,760 | 11,290 | 9,876 | 2,850 | 5,054 | + 2,204 |
| Wayne | 105,170 | 98,879 | 112,549 | 136,694 | 146,901 | + 10,207 |
| Webster | 138,206 | 134,538 | 113,393 | 109,522 | 80,275 | − 29,247 |
| Other counties and small mines | 21,867 | 23,865 | 32,773 | 25,100 | 23,907 | − 1,193 |
| Total | 6,419,811 | 6,519,933 | 6,798,609 | 7,266,224 | 7,574,322 | + 308,098 |
| Total value | $10,563,910 | $10,504,406 | $10,586,381 | $11,619,455 | $12,258,012 | +$638,557 |

The coal fields of Iowa occupy the south-central and southwestern portions of the State. They include an area of approximately 20,000 square miles, of which 13,000 may be considered probably productive territory. The beds belong to the Pennsylvanian series of the Carboniferous and include shales, sandstones, limestones, and coal. There are two well-recognized divisions, of which the lower, locally known as the Des Moines group, is the more productive part. In this formation the sandstones are thick and abundant, the shales are largely arenaceous and bituminous, and the coal beds while thick are with one exception very irregularly distributed. In the upper portion of the formation certain thin limestones appear, and associated with them is a coal known as the Mystic or Centerville block, which extends with great regularity through a considerable area in Appanoose and Wayne counties.

The upper coal-bearing rocks, or the Missouri group, consist largely of limestones and calcareous clays and carry only one coal bed of any importance. This is 20 inches thick and is mined locally in Adams, Taylor, and Page counties. The rocks as a whole dip from 10 to 20 feet to the mile to the southwest and increase in thickness from their outcrop to a maximum of approximately 1,000 feet. The coal is of the dry, noncoking, bituminous variety. The more important productive areas are: (1) The northern, including Webster, Boone, and adjacent counties, and yielding approximately 7 per cent of the total output; (2) the north-central, including Polk and Jasper counties, and yielding 20 per cent of the output; (3) the south-central, including Monroe, Wapello, Mahaska, Marion, and adjacent counties, and contributing more than 50 per cent of the total output; (4) the southern district, including Appanoose and Wayne counties, and yielding 16 per cent of the output from the coal bed already mentioned.

Iowa probably ranks second among the States west of the Mississippi River in order of priority as a coal producer. At the time of taking the United States census for 1840 Iowa and Missouri were the only States west of the river in which any coal production was reported. Missouri, however, was credited with an output of nearly 10,000 tons, while Iowa's production was given at 400 tons. It is probable, therefore, that the first mine opened in Missouri antedated Iowa's initial production. The production of coal in Iowa since 1840 will be found in the table on a preceding page, giving the history of coal production in the United States from the earliest times to the close of 1907.

Iowa's total production of coal from 1840 to the close of 1907 has amounted to 141,608,792 short tons, which, including the waste of the half ton lost for every ton of coal mined and marketed, is equivalent to an exhaustion of 212,000,000 tons. Mr. Campbell estimates the original coal supply of Iowa at 29,160,000,000 tons. This would leave about 3,820 times the production in 1907. If the ratio of waste to marketed coal continues at the same rate, the supply would last 2,550 years at the rate of production in 1907.

## KANSAS.

Total production in 1907, 7,322,449 short tons; spot value, $11,159,698.

In Kansas, as in Iowa, Missouri, and the other States of the western interior coal field, the monetary disturbances in the latter part of 1907 exerted comparatively little influence. The year was one of exceptional activity and prosperity for the coal-mining industry in these

States, shortage of labor and of car supply, together with dissatisfaction with the railway rates being the principal cause of complaint. In Kansas the production in 1907 exceeded that of 1906 by 1,297,674 short tons, or 21.53 per cent, in quantity, and by $2,180,145, or 24.28 per cent, in value. The coal output of the State in 1907 was more than double that of 1898 (9 years earlier), and the increase in 1907 over 1906 was larger than the total production of the State in 1885. In the report for 1906 it was stated that the coal-mining industry in Kansas for that year was adversely affected by the increased production and use of petroleum and natural gas. The statistics for 1907 indicate that the development of industries dependent upon petroleum and natural gas had caused an increase of population and also augmented the demand for coal for domestic use and railroad consumption. The fact that the average price advanced from $1.49 in 1906 to $1.52 in 1907 shows that the increased production was not greater than the markets required.

The shortage in the labor supply is adequately exhibited in the statistics for 1907, which show that although the production increased nearly 22 per cent over 1906, there was a decided falling off in the number of men employed in its production. In 1907 the total number of men employed was 12,439, whereas in 1906 there were 14,355 men employed. The average number of working days, however, in 1907 was 225, as compared with 165 in 1906, in which year on account of the suspension pending the adjustment of the wage question, 11,827 men were idle for an average of 59 days. The average production per man in 1907 was 589 tons, against 419.7 tons in 1906 and 538.7 tons in 1905. The average daily production per man was 2.62 tons in 1907, against 2.54 tons in both 1905 and 1906.

The quantity of coal mined by machinery in Kansas did not materially affect the production, there being only 6 machines in use and 35,317 tons of machine-mined coal produced in 1907.

Of the men employed in the coal mines of the State, 10,980, or practically 90 per cent, worked 8 hours a day. These were distributed among 134 mines. Ten mines, employing 156 men, worked 9 hours, and one mine, employing 10 men, worked 10 hours. There were 1,293 men employed in the coal mines of Kansas for whom the number of hours worked was not reported.

During 1907 there were 923 men who were on strike for an average of 18 days, the time lost being equivalent to 0.6 per cent of the total working time, while in 1906 the time lost by idleness was equivalent to 25 per cent of the time made.

According to Mr. Frank Gilday, State mine inspector, there were 32 men killed and 48 injured in the coal mines of Kansas during 1907. Of the 32 fatal accidents, 9 were due to explosions of gas or dust, 1 to an explosion of powder, 17 to falls of roof or coal, 3 men were run over by cars, 1 was killed by falling down a shaft, and 1 by falling off a tipple. The death rate per thousand of employees was 2.57, and the number of tons mined for each life lost was 228,827.

The statistics of the production of coal in Kansas in 1906 and 1907, by counties, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Kansas in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | |
| Cherokee | 1,930,359 | 38,072 | 46,676 | ....... | 2,015,107 | $2,906,332 | $1.44 | 188 | 3,702 |
| Crawford | 3,227,409 | 131,776 | 55,883 | ....... | 3,415,068 | 4,833,087 | 1.42 | 151 | 8,163 |
| Leavenworth | 250,978 | 76,747 | 48,950 | 1,171 | 377,846 | 723,491 | 1.91 | 216 | 1,221 |
| Linn | 18,810 | 12,797 | 1,045 | ....... | 32,652 | 56,708 | 1.74 | 192 | 146 |
| Osage | 117,457 | 20,012 | 277 | ....... | 137,746 | 361,517 | 2.62 | 133 | 956 |
| Other counties [a] | 2,200 | 23,045 | 10,410 | ....... | 35,655 | 73,927 | 2.07 | 121 | 167 |
| Small mines | ........... | 10,701 | ......... | ....... | 10,701 | 24,491 | 2.29 | ........ | ........ |
| Total | 5,547,213 | 313,150 | 163,241 | 1,171 | 6,024,775 | 8,979,553 | 1.49 | 165 | 14,355 |
| **1907.** | | | | | | | | | |
| Cherokee | 2,249,060 | 27,952 | 48,732 | ....... | 2,325,744 | $3,454,966 | $1.49 | 230 | 3,803 |
| Crawford | 4,224,369 | 59,444 | 96,815 | ....... | 4,380,628 | 6,302,990 | 1.44 | 227 | 6,606 |
| Leavenworth | 338,335 | 40,496 | 45,507 | ....... | 424,338 | 923,508 | 2.18 | 249 | 1,197 |
| Linn | 16,411 | 10,794 | 283 | ....... | 27,488 | 51,488 | 1.87 | 206 | 66 |
| Osage | 122,978 | 14,771 | 300 | ....... | 138,049 | 363,532 | 2.63 | 149 | 736 |
| Other counties [b] | 1,200 | 11,312 | ......... | ....... | 12,512 | 34,161 | 2.73 | 200 | 19 |
| Small mines | ........... | 13,690 | ......... | ....... | 13,690 | 29,053 | 2.12 | 225 | 12 |
| Total | 6,952,353 | 178,469 | 191,637 | ....... | 7,322,449 | 11,159,698 | 1.52 | 225 | 12,439 |

[a] Atchison, Bourbon, Cloud, Franklin, Jewell, and Labette.
[b] Bourbon, Cloud, Franklin.

The statistics of production by counties during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Kansas, 1903–1907, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (–), 1907. |
|---|---|---|---|---|---|---|
| Atchison | ......... | ......... | ......... | (a) | ......... | ......... |
| Cherokee | 2,062,897 | 2,378,624 | 2,132,589 | 2,015,107 | 2,325,744 | + 310,637 |
| Cloud | 2,400 | 3,000 | 3,000 | 3,000 | 6,512 | + 3,512 |
| Crawford | 3,132,595 | 3,399,334 | 3,729,953 | 3,415,068 | 4,380,628 | + 965,560 |
| Franklin | 4,900 | 4,740 | 1,950 | 2,300 | 3,560 | + 1,260 |
| Leavenworth | 382,828 | 333,419 | 348,322 | 377,846 | 424,338 | + 46,492 |
| Linn | 47,617 | 29,657 | 30,673 | 32,652 | 27,488 | – 5,164 |
| Osage | 194,727 | 171,454 | 157,327 | 137,746 | 138,049 | + 303 |
| Other counties and small mines | 12,012 | 13,079 | 20,165 | 41,056 | 16,130 | – 24,926 |
| Total | 5,839,976 | 6,333,307 | 6,423,979 | 6,024,775 | 7,322,449 | + 1,297,674 |
| Total value | $8,871,953 | $9,640,771 | $9,350,542 | $8,979,553 | $11,159,698 | +$2,180,145 |

[a] Included in other counties.

The coal measures of Kansas occupy the eastern portion of that State and underlie approximately 20,000 square miles, of which 15,000 have been estimated as probably more or less productive. The coal measures belong to the Pennsylvanian series of the Carboniferous, and include the southwestern extension of the Iowa-Missouri field. The formation differs somewhat from that of the adjacent States in that the division between the upper and lower portion is not so well marked. The limestones, which in Iowa and Missouri characterize especially the upper portion of the coal measures, are more prominent in Kansas, and coal is also found to some extent in the upper beds as well as in the lower. The total thickness of the coal measures has been estimated at 3,000 feet. The dip is to the north and west, and the beds increase in thickness in that direction. The most important coal field in the State is that of Cherokee and Crawford counties, in the southeastern corner. In this field the Cherokee bed, which varies in thickness from 3 to 10 feet and has a general average of 40 to 42 inches, is largely mined. The coal is of better grade than that found in the adjacent States, and the mining conditions as regards roof and floor are excellent. Approximately 91 per cent of the output of the State comes from these counties. Some of the coal mined in this district possesses coking qualities, and a small quantity of coke is made from slack coal produced at the mines in the vicinity of Pittsburg. About half of the coal used in coke making is washed before being charged into the ovens. The coke is used by the zinc smelters in and about Pittsburg.

Some of the coal beds lie very near the surface, and mining operations are carried on by removing the overburden and stripping the coal. Some of this strip-pit coal is used raw in the smelting of zinc, for which purposes its absolute noncoking qualities make it especially adaptable. This fuel is known locally as "dead coal."

The second district of importance is that adjacent to Leavenworth and Atchison, in the northeastern portion of the State, where, at a depth of from 700 to 1,150 feet and at horizons equivalent to those mined in eastern Missouri, a thin bed of coal is found. This field yields a trifle less than 6 per cent of the total output of the State and is notable as being the only point at which deep mining is carried on in the Western Interior coal field. The third important district in Kansas is that of Osage and adjacent counties, in which a coal bed 20 to 22 inches thick is mined and yields approximately 3 per cent of the State's output. This bed is notable as being well up in the upper coal measures and stratigraphically 2,000 feet above the Cherokee coal. It occupies approximately the horizon of the bed locally mined in southwestern Iowa.

The earliest record of coal production in Kansas shows that the State produced in 1869 a total of 36,891 tons. From 1870 to 1880 the production has been estimated from the best information obtainable, and since 1882 it has been collected by the statistical division of the United States Geological Survey, as shown in the table on a preceding page giving the history of coal production in the United States from the earliest times to the close of 1907.

According to the estimates of Mr. M. R. Campbell, the total area of Kansas known to contain workable coal beds is 3,100 square miles, while the area of which little is known, but which may contain workable coal, is estimated at 15,780 square miles. The original coal supply is estimated to have been 7,022,000,000 short tons, from which there had been mined, to the close of 1907, 91,176,204 short tons. This represents an exhaustion, including the loss in mining, of about 136,000,000 short tons. Thus it would appear that about 1.9 per cent of the supply has been exhausted.

## KENTUCKY.

Total production in 1907, 10,753,124 short tons; spot value, $11,405,038.

In the preliminary statement giving a review of the coal-mining industry in 1907, published through the press early in February, it was estimated that the production of Kentucky had increased about 10 per cent over that of 1906. The complete statistics for the State, as reported to the Geological Survey, show that the production actually increased 1,099,477 short tons, or 11.39 per cent in quantity, and $1,595,100, or 16.26 per cent in value. It is believed that this increase would have been considerably greater, in spite of the financial flurry, had ordinary weather conditions prevailed during November and December. The temperature of these months was abnormally high and there was not the usual demand for local consumption. As a consequence the coal dealers were stocked, and prices at the close of the year were badly depressed. The first nine months of the year were highly favorable to the trade, and the monetary disturbances during the latter part, while exercising a baneful influence, would not have been so disastrous if the weather had been seasonable. It was reported that labor for the first eight months of the year was scarce, independent, and unsatisfactory, many of the miners having, because of the demand for labor in less exacting classes of employment, left the coal fields and obtained work elsewhere.

During 1906 many new developments started in the coal-mining districts of southeastern Kentucky, although several of these were not fully opened up during 1907. The development of these properties resulted in a further division of an already limited car supply, and while there was an increase in production for the State, many of the older companies showed a decrease, particularly in the southeastern district, as the car supply at many of the mines was not more than 50 per cent of the requirements, and in addition to this the miners were disposed to seek employment in the newer operations where access to the working places is easier than in the older mines.

With the close of 1907 Kentucky completed a record of eleven years of unbroken increase in the production of coal and attained the maximum output in the history of the State. The output in 1907 was nearly three times that of 1897 and nearly double that of 1901.

During 1907 the coal mines of Kentucky gave employment to 16,971 men, who worked an average of 210 days, against 15,272 men for an average of 212 days in 1906 and 14,685 men for an average of 200 days in 1905. A large proportion—more than two-thirds—of the mines of Kentucky are operated on the "open-shop," or nonunion, basis, and in consequence the 8-hour day is not so generally observed as in some of the other coal-mining States. In 1907, out of a total of 16,971 men, 6,842 worked 10 hours a day, 4,508 worked 9 hours a day, and 4,610 worked 8 hours. The average production per man in 1907 was 3.02 tons, compared with 2.98 in 1906 and 2.87 in 1905. The average production for each employee for the year 1907 was 634, compared with 632.1 in 1906 and 574.2 in 1905. These figures indicate a steady improvement in the productive capacity per employee, due in part at least to the growth in the use of undercutting machines, Kentucky being one of the most progressive States in this regard.

In 1903 there were 308 mining machines in use; in 1904 there were 453; in 1905, 527; in 1906, 600; and in 1907, 708. The machine-mined coal produced in these five years has been, in 1903, 2,843,805 tons; in 1904, 3,595,513 tons; in 1905, 4,409,054 tons; in 1906, 5,175,950 tons; and in 1907, 5,504,262 tons. The machine-mined product in 1907 was 51.19 per cent of the total production, a percentage of increase exceeded only by one State—Ohio.

The casualty records in the coal mines of Kentucky in 1907, as reported by Mr. C. J. Norwood, State inspector of mines, shows that there were 32 men killed and 86 seriously injured during the year. None of the deaths were due to explosions of gas or dust. Two were due to powder explosions, 2 to premature blasts, 12 to falls of roof, 4 to car or motor accidents, 1 to electricity, 1 to a fall into a shaft, and 2 from falls from cages. Four men were killed outside the mines, and 4 deaths are attributed to miscellaneous causes. The death rates per thousand of employees was 1.9, and the number of tons mined for each life lost was 336,035.

The St. Bernard Mining Company, of Earlington, is the only company in the State which has reported the installation of a washing plant for improving the quality of its product. This company reported having washed in 1907, 99,763 tons of coal, which yielded 88,678 tons of cleaned coal and 11,085 tons of refuse. The same company reported in 1906, 92,612 tons of coal washed, which yielded 82,322 tons of cleaned coal and 10,290 tons of refuse.

According to the estimates of Mr. M. R. Campbell, the original coal supply in the State of Kentucky, when mining first began, was 104,028,000,000 short tons, of which 67,787,000,000 tons were in the eastern Kentucky region and 36,241,000,000 tons were included in the coal areas of the western part of the State. From the total original supply there had been mined to the close of 1907, according to the best records obtainable, approximately 122,400,000 tons, which represents an exhaustion estimated at 184,000,000 tons, or 0.18 of 1 per cent of the original supply.

The statistics of production of coal in 1906 and 1907, by counties, with the distribution of the product for consumption, are shown in the following tables:

## *Coal production of Kentucky in 1906 and 1907, by counties, in short tons.*

### 1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bell | 911,430 | 23,615 | 17,806 | 36,257 | 989,108 | $1,122,526 | $1.13 | 212 | 1,737 |
| Boyd | 46,322 | 2,500 | | | 48,822 | 38,540 | .79 | 235 | 74 |
| Carter | 154,482 | 3,666 | 600 | | 158,748 | 144,899 | .91 | 222 | 323 |
| Daviess | | 51,421 | 1,222 | | 52,643 | 64,948 | 1.23 | 228 | 84 |
| Hancock | 22,600 | 6,387 | 58 | | 29,045 | 34,537 | 1.19 | 225 | 73 |
| Henderson | 130,818 | 59,651 | 10,538 | | 201,007 | 222,957 | 1.11 | 204 | 383 |
| Hopkins and Christian | 2,019,015 | 49,728 | 84,052 | 92,612 | 2,245,407 | 1,884,034 | .84 | 250 | 2,389 |
| Johnson | 86,854 | 1,936 | 661 | | 89,451 | 96,817 | 1.08 | 178 | 285 |
| Knox | 532,805 | 8,730 | 8,191 | | 549,726 | 609,001 | 1.11 | 184 | 927 |
| Laurel | 388,558 | 7,540 | 6,275 | | 402,373 | 430,069 | 1.07 | 211 | 849 |
| Lee | 80,318 | 1,000 | 500 | | 81,818 | 107,617 | 1.32 | 204 | 138 |
| McLean | 163,469 | 2,791 | 2,165 | | 168,425 | 157,969 | .94 | 224 | 217 |
| Morgan | 55,206 | 3,110 | 920 | | 59,236 | 135,996 | 2.30 | 229 | 192 |
| Muhlenberg | 1,450,651 | 13,759 | 27,921 | | 1,492,331 | 1,371,283 | .92 | 227 | 2,053 |
| Ohio | 672,116 | 14,697 | 20,772 | | 707,585 | 649,226 | .92 | 204 | 1,053 |
| Pike | 298,585 | 5,225 | 4,949 | | 308,759 | 281,082 | .91 | 158 | 684 |
| Pulaski | 176,582 | 1,878 | 3,260 | | 181,720 | 242,254 | 1.33 | 185 | 453 |
| Union | 350,802 | 43,695 | 14,862 | 6,654 | 416,013 | 453,577 | 1.09 | 231 | 562 |
| Webster | 436,148 | 44,556 | 20,726 | | 501,430 | 456,297 | .91 | 206 | 635 |
| Whitley | 748,648 | 18,795 | 13,911 | | 781,354 | 1,075,212 | 1.38 | 194 | 1,787 |
| Other counties [a] | 104,092 | 24,134 | 7,505 | | 135,731 | 163,130 | 1.20 | 181 | 374 |
| Small mines | | 52,915 | | | 52,915 | 67,967 | 1.28 | | |
| Total | 8,829,501 | 441,729 | 246,894 | 135,523 | 9,653,647 | 9,809,938 | 1.02 | 212 | 15,272 |

### 1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Bell | 1,370,179 | 33,066 | 27,977 | 6,664 | 1,437,886 | $1,700,111 | $1.18 | 232 | 2,668 |
| Boyd | 52,456 | 2,828 | | | 55,284 | 45,479 | .82 | 208 | 319 |
| Carter | 116,343 | 3,284 | 1,000 | | 120,627 | 119,266 | .99 | 219 | 272 |
| Daviess | 39,970 | 32,716 | 1,221 | | 73,907 | 96,450 | 1.31 | 234 | 117 |
| Henderson | 149,370 | 61,255 | 6,957 | | 217,582 | 247,681 | 1.14 | 223 | 453 |
| Hopkins and Christian | 1,892,959 | 63,645 | 70,688 | 99,763 | 2,127,055 | 1,860,697 | .87 | 230 | 2,334 |
| Johnson | 119,087 | 1,538 | 1,965 | | 122,590 | 170,897 | 1.39 | 160 | 299 |
| Knox | 684,581 | 11,991 | 9,919 | | 706,491 | 837,361 | 1.19 | 199 | 1,100 |
| Laurel | 308,636 | 5,076 | 5,569 | | 319,281 | 368,602 | 1.15 | 219 | 598 |
| Lee | 57,882 | 4,309 | 450 | | 62,641 | 97,168 | 1.55 | 222 | 95 |
| McLean | 142,449 | 6,273 | 1,483 | | 150,205 | 159,778 | 1.06 | 191 | 231 |
| Morgan | 57,647 | 5,779 | 1,159 | | 64,585 | 172,920 | 2.68 | 215 | 201 |
| Muhlenberg | 1,826,637 | 21,524 | 34,752 | | 1,882,913 | 1,792,571 | .95 | 209 | 2,365 |
| Ohio | 630,075 | 12,547 | 16,023 | | 658,645 | 618,386 | .94 | 183 | 991 |
| Pike | 525,172 | 3,394 | 5,121 | | 533,687 | 497,866 | .93 | 212 | 795 |
| Pulaski | 128,172 | 3,527 | 3,526 | | 135,225 | 191,079 | 1.41 | 168 | 412 |
| Union | 442,590 | 43,302 | 18,399 | 3,564 | 507,855 | 512,877 | 1.01 | 205 | 861 |
| Webster | 549,263 | 38,484 | 20,946 | | 608,693 | 569,780 | .94 | 193 | 749 |
| Whitley | 732,033 | 17,461 | 13,429 | | 762,923 | 1,086,564 | 1.42 | 197 | 1,807 |
| Other counties [b] | 86,214 | 19,559 | 14,095 | | 119,868 | 146,710 | 1.22 | 206 | 304 |
| Small mines | | 85,181 | | | 85,181 | 112,795 | 1.32 | | |
| Total | 9,911,715 | 476,739 | 254,679 | 109,991 | 10,753,124 | 11,405,038 | 1.06 | 210 | 16,971 |

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[a] Breathitt, Butler, Clay, Floyd, Greenup, Harlan, Knott, Lawrence, Leslie, Letcher, Menifee, Owsley, Rockcastle, and Wayne.

[b] Breathitt, Butler, Floyd, Greenup, Hancock, Harlan, Knott, Lawrence, Leslie, Magoffin, Menifee, Owsley, Rockcastle, and Wayne.

In the following table is presented a statement of the production of coal in Kentucky, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906:

*Coal production of Kentucky, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Bell | 392,016 | 521,662 | 757,413 | 989,108 | 1,437,886 | + 448,778 |
| Boyd | 245,491 | 69,095 | 48,304 | 48,822 | 55,284 | + 6,462 |
| Breathitt and Lee | 80,301 | 110,303 | 126,937 | 119,168 | 87,941 | − 31,227 |
| Butler | 3,600 | 1,647 | 18,199 | 15,735 | 10,271 | − 5,464 |
| Carter | 265,226 | 245,030 | 145,169 | 158,748 | 120,627 | − 38,121 |
| Christian, Daviess, and Hancock | 180,544 | 185,922 | 199,368 | 161,753 | 150,248 | − 11,505 |
| Greenup | 3,167 | 2,742 | 1,543 | 719 | 902 | + 183 |
| Henderson | 178,871 | 151,103 | 175,226 | 201,007 | 217,582 | + 16,575 |
| Hopkins | 1,743,721 | 1,691,675 | 2,013,715 | 2,165,342 | 2,064,154 | − 101,188 |
| Johnson | 77,100 | 41,120 | 57,310 | 89,451 | 122,590 | + 33,139 |
| Knox | 543,557 | 577,778 | 579,386 | 549,726 | 706,491 | + 156,765 |
| Laurel | 392,288 | 380,667 | 445,958 | 402,373 | 319,281 | − 83,092 |
| Lawrence | 66,826 | 69,036 | 37,481 | 47,279 | 29,673 | − 17,606 |
| McLean | 127,869 | 117,616 | 109,429 | 168,425 | 150,205 | − 18,220 |
| Muhlenberg | 798,892 | 934,048 | 1,050,501 | 1,492,331 | 1,882,913 | + 390,582 |
| Ohio | 586,072 | 514,126 | 542,327 | 707,585 | 658,645 | − 48,940 |
| Pulaski | 196,287 | 197,796 | 184,319 | 181,720 | 135,225 | − 46,495 |
| Rockcastle | 56,901 | 139,340 | 114,356 | 13,358 | 6,500 | − 6,858 |
| Union | 349,625 | 368,194 | 382,956 | 416,013 | 507,855 | + 91,842 |
| Webster | 371,560 | 298,715 | 347,817 | 501,430 | 608,693 | + 107,263 |
| Whitley | 710,747 | 788,836 | 793,902 | 781,354 | 762,923 | − 18,431 |
| Other counties and small mines | 167,371 | 170,031 | 300,912 | 442,200 | 717,235 | + 275,035 |
| Total | 7,538,032 | 7,576,482 | 8,432,523 | 9,653,647 | 10,753,124 | + 1,099,477 |
| Total value | $7,979,342 | $7,868,192 | $8,385,232 | $9,809,938 | $11,405,038 | +$1,595,100 |

As Kentucky's coal product is drawn from two of the great coal fields, a comparison of the two sections is of some interest. The following tables show the production in the eastern and western districts, by counties, during the last five years with the increases and decreases in 1907. In 1906 nearly 80 per cent of the increased production over 1905 was in the western district, which showed a gain of 959,070 short tons, as compared with the increase of 262,054 short tons in the eastern district. The influence of the development in the eastern portion of the State, which has already been referred to, is shown by the fact that in 1907 more than 60 per cent of the total increase was in the eastern district, which exhibits a gain of 689,076 short tons, as compared with an increase of 410,401 tons in the western district. It will be observed, however, that while according to Mr. Campbell's estimate nearly two-thirds of the coal supply of Kentucky is contained in the areas of the eastern part of the State, considerably more than 60 per cent of the total production during recent years has come from the western district.

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*Coal production of the eastern district of Kentucky, 1903–1907, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (–), 1907. |
|---|---|---|---|---|---|---|
| Bell | 392,016 | 521,662 | 757,413 | 989,108 | 1,437,886 | +448,778 |
| Boyd | 245,491 | 69,095 | 48,304 | 48,822 | 55,284 | + 6,462 |
| Breathitt | 32,730 | 42,355 | 32,340 | 37,350 | 25,300 | – 12,050 |
| Carter | 265,226 | 245,030 | 145,169 | 158,748 | 120,627 | – 38,121 |
| Greenup | 3,167 | 2,742 | 1,543 | 719 | 902 | + 183 |
| Johnson | 77,100 | 41,120 | 57,310 | 89,451 | 122,590 | + 33,139 |
| Knox | 543,557 | 577,778 | 579,386 | 549,726 | 706,491 | +156,765 |
| Laurel | 392,288 | 380,667 | 445,958 | 402,373 | 319,281 | – 83,092 |
| Lawrence | 66,826 | 69,036 | 37,481 | 47,279 | 29,673 | – 17,606 |
| Lee | 47,571 | 67,948 | 94,597 | 81,818 | 62,641 | – 19,177 |
| Pulaski | 196,287 | 197,796 | 184,319 | 181,720 | 135,225 | – 46.495 |
| Rockcastle | 56,901 | 139,340 | 114,356 | 13,358 | 6,500 | – 6,858 |
| Whitley | 710,747 | 788,836 | 793,902 | 781,354 | 762,923 | – 18,431 |
| Other counties and small mines | 129,065 | 68,013 | 214,519 | 386,825 | 672,404 | +285,579 |
| Total | 3,158,972 | 3,211,418 | 3,506,597 | 3,768,651 | 4,457,727 | +689,076 |

*Coal production of the western district of Kentucky, 1903–1907, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (–), 1907. |
|---|---|---|---|---|---|---|
| Butler | 3,600 | 1,647 | 18,199 | 15,735 | 10,271 | – 5,464 |
| Christian | 99,226 | 91,943 | 89,766 | 80,065 | 62,901 | – 17,164 |
| Daviess | 44,286 | 44,125 | 61,780 | 52,643 | 73,907 | + 21,264 |
| Hancock | 37,032 | 49,854 | 47,817 | 29,045 | 13,440 | – 15,605 |
| Henderson | 178,871 | 151,103 | 175,226 | 201,007 | 217,582 | + 16,575 |
| Hopkins | 1,743,721 | 1,691,675 | 2,013.715 | 2,165,342 | 2,064,154 | –101,188 |
| McLean | 127,869 | 117,616 | 109,429 | 168,425 | 150,205 | – 18,220 |
| Muhlenberg | 798,892 | 934,048 | 1,050,501 | 1,492,331 | 1,882,913 | +390,582 |
| Ohio | 586,072 | 514,126 | 542,327 | 707,585 | 658,645 | – 48,940 |
| Union | 349,625 | 368,194 | 382.956 | 416,013 | 507,855 | + 91,842 |
| Webster | 371,560 | 298,715 | 347,817 | 501,430 | 608,693 | +107,263 |
| Other counties and small mines | 38,306 | 102,018 | 86,393 | 55,375 | 44,831 | – 10,544 |
| Total | 4,379,060 | 4,365,064 | 4,925,926 | 5,884,996 | 6,295,397 | +410,401 |

Kentucky is the only one of the coal-producing States which has within its borders areas belonging to any two of the great coal fields. The eastern counties of the State are underlain by the coal beds of the great Appalachian system, extending entirely across the State in a northeast-southwest direction, while the southern limits of the Central or Eastern Interior field are found in the more northern counties of the western part of the State. The total area underlain by coal in the eastern counties of Kentucky is estimated at 10,270 square miles, and the coal-bearing areas in the western part of the State are estimated to contain 6,400 square miles, or somewhat more than one-half of that of the eastern part. Up to the close of 1907 the western district, however, produced considerably more than half the total output of the State, but the recent developments in Pike, Johnson, and other counties of the eastern portion of Kentucky, lead to the impression that the production in the eastern district will soon exceed that of the western.

From a practical standpoint, the eastern Kentucky coal field is a unit, unless the Middlesboro-Harlan field, cut off by the Pine Mountain fault, be excepted. The great bulk of the area of this field (10,270 square miles) has at present no transportation facilities, and development has been confined to the close proximity of the few lines of railroad that cross or enter the field. Thus, at the north there are about a dozen commercial mines on the Chesapeake and Ohio Railroad, where it crosses Carter and Boyd counties. Lawrence, Johnson, Lee, and Breathitt counties each support a few mines. The Chesapeake and Ohio has completed a line into the Elkhorn field, which promises to become one of the most important in the State. The larger mines are mostly in the southern portion of the field. Along the Cincinnati Southern are a group of mines in Pulaski County and western Whitley County. Along the Louisville and Nashville are a detached group of mines in Laurel County, and scattered mines in Knox, Bell, and Whitley counties.

The coals of this field belong to the "Lower Productive Coal Measures" and Pottsville formation of Pennsylvania. The latter formation, which at the Ohio River has a thickness of only a few hundred feet and carries 5 coals, in the southeastern corner of the State is about 5,000 feet thick and carries nearly 50 coals, of which a dozen or more are locally of workable thickness and quality. The eastern Kentucky coals are mostly high-grade "gas" or "coking" coals, with some cannel coal. In the Jellico coal field the Jellico and the Blue Gem seams are both thin, the latter being successfully mined where averaging only 22 inches. On the other hand, some of the seams show 8 and 9 feet or more of workable coal.

The workable coal of the western district of Kentucky is confined almost entirely to two beds, designated as Nos. 9 and 11 by the geological survey of Kentucky. Of these, No. 9 is the more persistent and furnishes probably 75 per cent or more of the total production of the western counties of the State. It underlies the whole or portions of 8 counties, including all of the field except its eastern portion and the southern or southwestern edge and a few other places, where it has been cut out by irregularities in the structure. The bed has an average thickness of about 5 feet, and only rarely thickens out to more than 5 feet 6 inches or thins down to less than 4 feet 6 inches. It lies, as a rule, about 200 feet below the surface, and the mining is done by shaft. Seam No. 11 lies from 40 to 100 feet above No. 9, and is the next important bed in western Kentucky. It is much more irregular than No. 9, but usually where worked has a thickness of 6 feet or over. Another seam lying about 25 feet above No. 11 is known as No. 12. It is mined in Webster, Hopkins, McLean, and Muhlenberg counties. In the central portion of this field this bed attains a thickness of from 3 to 6 feet. Other seams beside these three are mined in the district, notably what is supposed to be No. 6 and also No. 5, near Dekoven, in Union County.

So far as the records of early coal production in the United States are to be accepted, Kentucky was the third State to enter the list of regular coal producers. According to one of the early reports of the Kentucky geological survey (published in 1838), the first coal produced in the State was mined in 1827 on "the right side of the (Cumberland) river below the mouth of Laurel." This was evidently from either Laurel or Pulaski County, but the exact location is not definitely stated. The same report says that in 1828 5 boat loads of coal from these mines arrived at Nashville, and that from 1829 to 1834 probably from 25 to 35 boat loads were sent out each year. The boat loads averaged about 1,750 bushels, or 66 tons each. From 1834 to 1837 the shipments were from 75 to 100 boat loads or about 3,500 bushels a year. The coal was for the most part consumed in the salt works and iron furnaces convenient to the rivers, the only means of transportation.

From the best information obtainable it seems that the production of the State from 1829 to 1835 ranged from 2,000 to 6,000 tons per year. The United States census for 1840 gives the total production for the State at 23,527 short tons. By 1860, according to the census for that year, the production amounted to 285,760 short tons. Operations were necessarily somewhat interrupted during the civil war, but since 1870, after the State had begun to recover from the effects of the war, the production increased rapidly, as shown in the table on a preceding page, giving the history of coal production in the United States from the earliest times to the close of 1907.

## MARYLAND.

Total production in 1907, 5,532,628 short tons; spot value, $6,623,697.

In spite of the business depression which began in October of 1907, and which seriously affected the coal-mining industry during the last three months of the year, the output of Maryland exceeded that of any previous year in the history of the State, and reached a total of 5,532,628 short tons. Compared with 1906, this indicates an increase of 97,175 tons, or 1.79 per cent, while the value increased from $6,474,793 to $6,623,697, a gain of $148,904, or 2.3 per cent. The average price per short ton in 1907 was $1.20, the highest figure recorded in the history of coal mining in the State, with the exception of 1903, when because of the famine brought about by the strike in the anthracite region of Pennsylvania in the preceding year, the price of Maryland coal rose to $1.48 and brought the total value of the production in that year up to $7,189,784, which was $566,087 in excess of the record made in 1907.

Owing to the comparatively limited extent of the Maryland coal fields, which are confined entirely to Allegany and Garrett counties in the western part of the State, it is not to be expected that the coal production of the future will show any material increase over the present record. The output in the last ten years has ranged from 4,024,688 short tons in 1900 to 5,532,628 short tons in 1907, and has averaged 4,962,811 short tons annually.

The average number of men employed in the coal mines of Maryland in 1907 was 5,880, as compared with 6,438 in 1906 and 5,948 in 1905. The average number of days that the mines were in operation, however, increased from 250 in 1906 to 263 in 1907. In 1905 the average number of days the mines were in operation was 252. With only a few exceptions, the coal mines of Maryland worked 10 hours a day. The average production per man in 1907 was 941 short tons, as compared with 844.3 tons in 1906 and 858.9 tons in 1905. The average daily production per man was 3.58 tons in 1907, as against 3.38 tons in 1906 and 3.41 tons in 1905. Maryland's record in tonnage per man, both per day and per year, is among the best of all the coal-producing States.

The statistics relating to the use of mining machines show that there were 43 machines in use in 1907, as against 45 in 1906, and the quantity of machine-mined coal increased from 427,450 short tons in

1906 to 479,110 short tons in 1907. The number of tons mined by machines was 8.66 per cent of the total product in 1907.

Labor disaffections in 1907 were limited to the mines of one company, at which 510 men were on strike for 27 days.

The statistics of accidents as collected by Mr. Thomas Murphy, State mine inspector, are taken for the fiscal year ending April 30, and the figures for 1907 were not available at the time of writing this report. In the fiscal year ending April 30, 1906, there were 7 fatal and 52 nonfatal accidents. The death rate per thousand of employees in that year was 1.09, and the number of tons mined for each life lost was 776,493.

The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

*Distribution of the coal product of Maryland, 1903–1907, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| 1903 | 4,752,716 | 53,022 | 40,427 | 4,846,165 | $7,189,784 | $1.48 | 219 | 5,859 |
| 1904 | 4,721,714 | 49,814 | 42,094 | 4,813,622 | 5,729,085 | 1.19 | 226 | 5,671 |
| 1905 | 5,010,997 | 49,779 | 47,763 | 5,108,539 | 5,831.760 | 1.14 | 252 | 5,948 |
| 1906 | 5,331,321 | 50,306 | 53,826 | 5,435,453 | 6,474,793 | 1.19 | 250 | 6,438 |
| 1907 | 5,427,882 | 48,461 | 56,285 | 5,532,628 | 6,623,697 | 1.20 | 263 | 5,880 |

The statistics of coal production in Maryland have been collected through a cooperative arrangement with the State Geological Survey, to which credit is also due for the following notes on the coal fields of the State:

The Maryland coals occur in five basins, known as the Georges Creek basin, the Upper Potomac basin, the Castleman basin, the Lower Youghiogheny basin, and the Upper Youghiogheny basin. The present production of coal for the market is almost exclusively confined to the first two basins. The far greater prominence of the Georges Creek basin has led to the application of the name "Georges Creek coal" to most of the coal shipped from the State. Until within recent years practically all of this coal came from the Pittsburg seam or "Big Vein," but the gradual exhaustion of this wonderful seam has led to the exploitation with most satisfactory results of many of the "Small Veins" both above and below the chief seam. There are many companies to-day mining the smaller seams either exclusively or in conjunction with the large seam. There is unquestionably a great future for these smaller seams in Maryland, especially in the Upper Potomac basin in southern Garrett County, where they reach their greatest thickness. The total amount of coal in these small seams exceeds many fold that originally contained in the "Big Vein."

The Maryland Geological Survey gives the following table showing the average composition of the coals from the different coal beds which are at present worked:

*Average composition of leading Maryland coals.*

| Coal seams. | Moisture. | Volatile carbon. | Fixed carbon. | Ash. | Sulphur. | Calorimetric values in— | |
|---|---|---|---|---|---|---|---|
| | | | | | | Calories. | British thermal units. |
| Upper Sewickley or "Tyson" | 0.83 | 20.22 | 70.09 | 8.86 | 1.40 | 7,784 | 14,011 |
| Pittsburg or "Big Vein" | .70 | 18.78 | 73.13 | 7.12 | 1.02 | 7,920 | 14,256 |
| Bakerstown or "Four-foot" | 1.10 | 18.64 | 70.32 | 9.94 | 2.07 | 7,757 | 13,973 |
| Upper Freeport or "Three-foot" | 1.21 | 19.47 | 68.70 | 10.17 | 1.73 | 7,764 | 13,975 |
| Lower Kittanning or "Six-foot" | 1.26 | 19.52 | 67.20 | 12.01 | 2.13 | 7,484 | 13,471 |
| Brookville or "Bluebaugh" | .91 | 21.04 | 68.83 | 9.22 | 1.30 | 7,729 | 13,912 |

The most important of the seams, after the Pittsburg or "Big Vein," are the Upper Sewickley, the Bakerstown, the Upper Freeport, and the Middle and Lower Kittanning, all of which are being successfully mined at the present time. Others, like the Franklin or "Dirty Nine," contain so little good coal as to be practically valueless.

Although coal was discovered in the Georges Creek basin as early as 1782, the first eastern shipments from the Maryland coal district were not made until 1830, when small amounts were transported by barges down the Potomac River. The first company was incorporated in 1836. Since the construction of the Baltimore and Ohio Railroad in 1842, and of the Chesapeake and Ohio Canal in 1850, the output from the Maryland mines has increased very rapidly, and more than 30 companies are now engaged in the mining of coal.

Several attempts to ship coal from the Maryland mines were made prior to the advent of the Baltimore and Ohio Railroad, barges having been loaded and floated down the Potomac River to Washington as early as 1830. This method was, however, too destructive of life and was the cause of so much loss in coal that it was soon abandoned, and it was not until 1842 that the industry really began to assume importance. The first shipments over the Chesapeake and Ohio Canal from Cumberland were made in 1850.

Maryland and the adjoining counties in West Virginia, which make up what is known as the Cumberland region, constitute the only districts outside of the anthracite region of Pennsylvania where records of coal production have been kept from the earliest years. These districts have been commonly known as the Georges Creek or Cumberland and the Piedmont regions. The Cumberland region was opened in 1842. The Piedmont region began shipping in 1853. The records of shipments have been carefully preserved and are published annually in the reports of the Cumberland Coal Trade, and the table following, which shows the shipments from this entire region, has been obtained from these reports.

The annual production from the mines of Maryland alone from 1842 to the close of 1907 will be found on a preceding page in the table giving the history of coal production in the United States from the earliest times.

*Total shipments from the Cumberland coal fields in Maryland*

| Year. | Frostburg region. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cumberland and Pennsylvania R. R. | | | | Cumberland Coal and Iron Company's R. R. | | |
| | By Baltimore and Ohio R. R. | By Chesapeake and Ohio Canal. | By Pennsylvania R. R. | Total. | By Baltimore and Ohio R. R. | By Chesapeake and Ohio Canal. | Total. |
| 1842 | 757 | | | 757 | 951 | | 951 |
| 1843 | 3,661 | | | 3,661 | 6,421 | | 6,421 |
| 1844 | 5,156 | | | 5,156 | 9,734 | | 9,734 |
| 1845 | 13,738 | | | 13,738 | 10,915 | | 10,915 |
| 1846 | 11,240 | | | 11,240 | 18,555 | | 18,555 |
| 1847 | 20,615 | | | 20,615 | 32,325 | | 32,325 |
| 1848 | 36,571 | | | 36,571 | 43,000 | | 43,000 |
| 1849 | 63,676 | | | 63,676 | 78,773 | | 78,773 |
| 1850 | 73,783 | 3,167 | | 76,950 | 119,023 | 875 | 119,898 |
| 1851 | 70,893 | 51,438 | | 122,331 | 103,808 | 31,540 | 135,348 |
| 1852 | 128,534 | 46,357 | | 174,891 | 139,925 | 19,362 | 159,287 |
| 1853 | 150,381 | 84,060 | | 234,441 | 155,278 | 70,535 | 225,813 |
| 1854 | 148,953 | 63,731 | | 212,684 | 173,580 | 92,114 | 265,694 |
| 1855 | 93,691 | 77,095 | | 170,786 | 97,710 | 100,691 | 198,401 |
| 1856 | 86,994 | 80,387 | | 167,381 | 121,945 | 105,149 | 227,094 |
| 1857 | 80,743 | 55,174 | | 135,917 | 88,573 | 54,000 | 142,573 |
| 1858 | 48,018 | 166,712 | | 214,730 | 66,009 | 87,539 | 153,548 |
| 1859 | 48,415 | 211,639 | | 260,054 | 72,423 | 86,203 | 158,626 |
| 1860 | 70,669 | 232,278 | | 302,947 | 80,500 | 63,600 | 144,100 |
| 1861 | 23,878 | 68,303 | | 92,181 | 25,983 | 29,296 | 55,279 |
| 1862 | 71,745 | 75,206 | | 146,951 | 41,096 | 23,478 | 64,574 |
| 1863 | 117,796 | 173,269 | | 291,065 | 111,087 | 43,523 | 154,610 |
| 1864 | 287,126 | 194,120 | | 481,246 | 67,676 | 64,522 | 132,198 |
| 1865 | 384,297 | 285,295 | | 669,592 | 104,651 | 57,907 | 162,558 |
| 1866 | 592,938 | 291,019 | | 883,957 | 52,251 | 52,159 | 104,410 |
| 1867 | 623,031 | 385,249 | | 1,008,280 | 40,106 | 72,904 | 113,010 |
| 1868 | 659,115 | 424,406 | | 1,083,521 | 100,345 | 57,919 | 158,264 |
| 1869 | 1,016,777 | 573,243 | | 1,590,020 | 130,017 | 78,908 | 208,925 |
| | | | | | 2,092,660 | 1,192,224 | 3,284,884 |
| | | | | | *Eckhart Branch R. R.* | | |
| 1870 | 909,511 | 520,196 | | 1,429,707 | 114,404 | 83,941 | 198,345 |
| 1871 | 1,247,279 | 656,085 | | 1,903,364 | 69,864 | 194,254 | 264,118 |
| 1872 | 1,283,956 | 612,537 | 22,021 | 1,918,514 | 26,586 | 203,666 | 230,252 |
| 1873 | 1,509,570 | 641,220 | 114,589 | 2,265,379 | 89,765 | 137,582 | 227,347 |
| 1874 | 1,295,804 | 631,882 | 67,671 | 1,995,357 | 113,670 | 135,182 | 248,852 |
| 1875 | 1,095,880 | 715,673 | 160,213 | 1,971,766 | 52,505 | 164,165 | 216,670 |
| 1876 | 939,262 | 443,435 | 131,866 | 1,514,563 | 15,285 | 189,005 | 204,290 |
| 1877 | 755,278 | 473,646 | 170,884 | 1,399,808 | 63,181 | 111,350 | 174,531 |
| 1878 | 823,801 | 486,038 | 145,864 | 1,455,703 | 99,455 | 123,166 | 222,621 |
| 1879 | 933,240 | 397,009 | 154,264 | 1,484,513 | 141,907 | 104,238 | 246,145 |
| 1880 | 1,055,491 | 471,800 | 213,446 | 1,740,737 | 197,525 | 131,325 | 328,850 |
| 1881 | 1,113,263 | 270,156 | 153,501 | 1,536,920 | 271,570 | 151,526 | 423,096 |
| 1882 | 576,701 | 115,344 | 91,574 | 783,619 | 199,183 | 76,140 | 275,323 |
| 1883 | 851,985 | 302,678 | 217,065 | 1,371,728 | 197,235 | 141,390 | 338,625 |
| 1884 | 1,193,780 | 150,471 | 199,138 | 1,543,389 | 289,884 | 124,718 | 414,602 |
| 1885 | 1,091,904 | 171,460 | 206,227 | 1,469,591 | 289,407 | 117,829 | 407,236 |
| 1886 | 1,131,949 | 115,531 | 141,520 | 1,389,000 | 243,321 | 113,791 | 357,112 |
| 1887 | 1,584,114 | 132,177 | 176,241 | 1,892,532 | 332,798 | 125,305 | 458,103 |
| 1888 | 1,660,406 | 155,216 | 193,046 | 2,008,668 | 374,888 | 95,191 | 470,079 |
| 1889 | 1,430,381 | 26,886 | 177,152 | 1,634,419 | 368,497 | 26,407 | 394,904 |
| 1890 | 1,511,418 | | 291,704 | 1,803,122 | 522,334 | | 522,334 |
| 1891 | 1,628,574 | 9,070 | 289,232 | 1,926,876 | 463,142 | 39,294 | 502,436 |
| 1892 | 1,426,994 | 93,705 | 214,011 | 1,734,710 | 349,207 | 170,116 | 519,323 |
| 1893 | 1,332,634 | 135,409 | 360,807 | 1,828,850 | 341,321 | 201,947 | 543,268 |
| 1894 | 1,068,739 | 95,523 | 372,205 | 1,536,467 | 436,216 | 208,914 | 645,130 |

*and West Virginia from 1842 to 1906, inclusive, in long tons.*

| Frostburg region. | | | | Piedmont region. | | Total. | | | Aggregate. |
|---|---|---|---|---|---|---|---|---|---|
| Georges Creek and Cumberland R. R. | | | | Georges Creek R. R. | Hampshire R. R. by Baltimore and Ohio R. R. | Baltimore and Ohio R. R. and local. | Chesapeake and Ohio Canal. | Pennsylvania R. R. | |
| By Chesapeake and Ohio Canal. | By Pennsylvania R. R. | Local and Baltimore and Ohio R. R. | Total. | | | | | | |
| ...... | ...... | ...... | ...... | ...... | ...... | 1,708 | ...... | ...... | 1,708 |
| ...... | ...... | ...... | ...... | ...... | ...... | 10,082 | ...... | ...... | 10,082 |
| ...... | ...... | ...... | ...... | ...... | ...... | 14,890 | ...... | ...... | 14,890 |
| ...... | ...... | ...... | ...... | ...... | ...... | 24,653 | ...... | ...... | 24,653 |
| ...... | ...... | ...... | ...... | ...... | ...... | 29,795 | ...... | ...... | 29,795 |
| ...... | ...... | ...... | ...... | ...... | ...... | 52,940 | ...... | ...... | 52,940 |
| ...... | ...... | ...... | ...... | ...... | ...... | 79,571 | ...... | ...... | 79,571 |
| ...... | ...... | ...... | ...... | ...... | ...... | 142,449 | ...... | ...... | 142,449 |
| ...... | ...... | ...... | ...... | ...... | ...... | 192,806 | 4,042 | ...... | 196,848 |
| ...... | ...... | ...... | ...... | ...... | ...... | 174,701 | 82,978 | ...... | 257,679 |
| ...... | ...... | ...... | ...... | ...... | ...... | 268,459 | 65,719 | ...... | 334,178 |
| ...... | ...... | ...... | ...... | 73,725 | ...... | 376,219 | 157,760 | ...... | 533,979 |
| ...... | ...... | ...... | ...... | 181,303 | ...... | 503,836 | 155,845 | ...... | 659,681 |
| ...... | ...... | ...... | ...... | 227,245 | 65,570 | 478,486 | 183,786 | ...... | 662,272 |
| ...... | ...... | ...... | ...... | 209,210 | 42,765 | 502,330 | 204,120 | ...... | 706,450 |
| ...... | ...... | ...... | ...... | 252,368 | 51,628 | 465,912 | 116,574 | ...... | 582,486 |
| ...... | ...... | ...... | ...... | 218,318 | 63,060 | 395,405 | 254,251 | ...... | 649,656 |
| ...... | ...... | ...... | ...... | 257,740 | 47,934 | 426,512 | 297,842 | ...... | 724,354 |
| ...... | ...... | ...... | ...... | 289,298 | 52,564 | 493,031 | 295,878 | ...... | 788,909 |
| ...... | ...... | ...... | ...... | 85,554 | 36,660 | 172,075 | 97,599 | ...... | 269,674 |
| ...... | ...... | ...... | ...... | 69,482 | 36,627 | 218,950 | 98,684 | ...... | 317,634 |
| ...... | ...... | ...... | ...... | 266,430 | 36,240 | 531,553 | 216,792 | ...... | 748,345 |
| ...... | ...... | ...... | ...... | ...... | 44,552 | 399,354 | 258,642 | ...... | 657,996 |
| ...... | ...... | ...... | ...... | ...... | 71,345 | 560,293 | 343,202 | ...... | 903,495 |
| ...... | ...... | ...... | ...... | ...... | 90,964 | 736,153 | 343,178 | ...... | 1,079,331 |
| ...... | ...... | ...... | ...... | ...... | 72,532 | 735,669 | 458,153 | ...... | 1,193,822 |
| ...... | ...... | ...... | ...... | ...... | 88,658 | 848,118 | 482,325 | ...... | 1,330,443 |
| ...... | ...... | ...... | ...... | ...... | 83,724 | 1,230,518 | 652,151 | ...... | 1,882,669 |
| | | | | 2,190,673 | | | | | |
| | | | | *Empire and West Virginia mines.* | | | | | |
| ...... | ...... | ...... | ...... | 28,035 | 60,988 | 1,112,938 | 604,137 | ...... | 1,717,075 |
| ...... | ...... | ...... | ...... | 81,218 | 96,453 | 1,494,814 | 850,339 | ...... | 2,345,153 |
| ...... | ...... | ...... | ...... | 85,441 | 121,364 | 1,517,347 | 816,103 | 22,021 | 2,355,471 |
| ...... | ...... | ...... | ...... | 77,582 | 103,793 | 1,780,710 | 778,802 | 114,589 | 2,674,101 |
| ...... | ...... | ...... | ...... | 57,492 | 109,194 | 1,576,160 | 767,064 | 67,671 | 2,410,895 |
| ...... | ...... | ...... | ...... | 63,537 | 90,800 | 1,302,237 | 879,838 | 160,698 | 2,342,773 |
| ...... | ...... | ...... | ...... | 108,723 | 7,505 | 1,070,775 | 632,440 | 131,866 | 1,835,081 |
| ...... | ...... | ...... | ...... | ...... | ...... | 818,459 | 584,996 | 170,884 | 1,574,339 |
| ...... | ...... | ...... | ...... | ...... | 998 | 924,254 | 609,204 | 145,864 | 1,679,322 |
| ...... | ...... | ...... | ...... | ...... | 51 | 1,075,198 | 501,247 | 154,264 | 1,730,709 |
| ...... | ...... | ...... | ...... | 66,573 | ...... | 1,319,589 | 603,125 | 213,446 | 2,136,160 |
| 83,136 | 125,097 | 4,947 | 213,180 | 88,722 | ...... | 1,478,502 | 504,818 | 278,598 | 2,261,918 |
| 78,298 | 93,861 | 31,436 | 203,595 | 277,929 | ...... | 1,085,249 | 269,782 | 185,435 | 1,540,466 |
| 215,767 | 202,223 | 77,829 | 495,819 | 338,001 | ...... | 1,444,766 | 680,119 | 419,288 | 2,544,173 |
| 69,765 | 156,959 | 283,336 | 510,060 | 466,928 | ...... | 2,233,928 | 344,954 | 356,097 | 2,934,979 |
| 79,455 | 214,518 | 291,685 | 585,658 | 403,489 | ...... | 2,076,485 | 368,744 | 420,745 | 2,865,974 |
| 53,480 | 98,371 | 348,196 | 500,047 | 346,308 | ...... | 2,069,774 | 282,802 | 239,891 | 2,592,467 |
| 4,863 | 153,230 | 418,057 | 576,150 | 449,011 | ...... | 2,724,347 | 262,345 | 389,104 | 3,375,796 |
| 112 | 286,787 | 341,024 | 627,923 | 564,397 | ...... | 2,669,216 | 286,700 | 715,151 | 3,671,067 |
| ...... | 365,029 | 243,487 | 608,516 | 576,047 | ...... | 2,357,585 | 57,459 | 798,842 | 3,213,886 |
| ...... | 677,593 | 228,138 | 905,731 | 774,904 | ...... | 2,723,341 | ...... | 1,282,748 | 4,006,089 |
| ...... | 763,845 | 229,266 | 993,111 | 959,673 | ...... | 2,855,225 | 51,121 | 1,474,087 | 4,380,433 |
| ...... | 568,003 | 236,314 | 804,317 | 971,214 | ...... | 2,557,177 | 266,901 | 1,205,486 | 4,029,564 |
| ...... | 741,954 | 201,938 | 943,892 | 1,031,797 | ...... | 2,423,159 | 338,107 | 1,586,541 | 4,347,807 |
| ...... | 773,074 | 111,036 | 884,110 | 900,399 | ...... | 2,084,265 | 304,437 | 1,577,404 | 3,966,106 |

*Total shipments from the Cumberland coal fields in Maryland*

| Year. | Frostburg region. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cumberland and Pennsylvania R. R. | | | | Cumberland Coal and Iron Company's R. R. | | |
| | By Baltimore and Ohio R. R. | By Chesapeake and Ohio Canal. | By Pennsylvania R. R. | Total. | By Baltimore and Ohio R. R. | By Chesapeake and Ohio Canal. | Total. |
| 1895 | 1,193,834 | 101,076 | 255,133 | 1,550,043 | 464,407 | 212,534 | 676,941 |
| 1896 | 1,344,402 | 169,195 | 163,471 | 1,677,068 | 610,418 | 195,279 | 805,697 |
| 1897 | 1,790,813 | 96,536 | 169,679 | 2,057,028 | 586,592 | 166,691 | 753,283 |
| 1898 | 2,131,626 | 24,997 | 116,195 | 2,272,818 | 507,196 | 213,139 | 720,335 |
| 1899 | 2,334,109 | 27,570 | 161,191 | 2,522,870 | 473,608 | 164,853 | 638,461 |
| 1900 | 1,813,462 | 14,621 | 126,615 | 1,954,698 | 304,320 | 96,513 | 400,833 |
| 1901 | 2,683,109 | 193,063 | 373,195 | 3,249,367 | (a) | (a) | (a) |
| 1902 | 2,981,013 | 192,557 | 250,822 | 3,424,392 | (a) | (a) | (a) |
| 1903 | 2,844,162 | 222,571 | 182,587 | 3,249,320 | (a) | (a) | (a) |
| 1904 | 2,792,462 | 205,964 | 234,502 | 3,232,928 | (a) | (a) | (a) |
| 1905 | 3,139,334 | 175,947 | 305,863 | 3,621,144 | (a) | (a) | (a) |
| 1906 | 3,235,501 | 199,505 | 430,328 | 3,865,334 | (a) | (a) | (a) |
| 1907 | 3,197,963 | 203,527 | 416,591 | 3,818,081 | (a) | (a) | (a) |
| Total | 65,865,165 | 13,192,424 | 7,450,403 | 86,507,992 | 8,609,691 | 4,219,351 | 12,829,042 |

[a] **Merged in Cumberland and Pennsylvania Railroad figures.**

*and West Virginia from 1842 to 1906, inclusive, in long tons*—Continued.

| Frostburg region. | | | | Piedmont region. | | Total. | | | Aggregate. |
|---|---|---|---|---|---|---|---|---|---|
| Georges Creek and Cumberland R. R. | | | | | | | | | |
| By Chesapeake and Ohio Canal. | By Pennsylvania R. R. | Local and Baltimore and Ohio R. R. | Total. | Georges Creek R. R. | Hampshire R. R. by Baltimore and Ohio R. R. | Baltimore and Ohio R. R. and local. | Chesapeake and Ohio Canal. | Pennsylvania R. R. | |
| 125 | 1,031,015 | 110,258 | 1,141,398 | 1,157,803 | ........ | 2,418,554 | 314,551 | 1,793,080 | 4,526,185 |
| ........ | 995,443 | 75,400 | 1,070,843 | 1,307,822 | ........ | 2,807,161 | 364,474 | 1,689,795 | 4,861,430 |
| ........ | 918,712 | 111,135 | 1,029,847 | 1,463,331 | ........ | 3,615,142 | 263,227 | 1,426,120 | 5,304,489 |
| ........ | 913,775 | 100,312 | 1,014,087 | 1,526,396 | ........ | 3,900,403 | 238,136 | 1,395,097 | 5,533,636 |
| ........ | 1,068,771 | 92,895 | 1,161,666 | 1,898,464 | ........ | 4,269,323 | 192,423 | 1,669,715 | 6,131,461 |
| ........ | 709,837 | 110,974 | 820,811 | 1,995,574 | ........ | 3,750,257 | 111,134 | 1,310,525 | 5,171,916 |
| ........ | 857,003 | 215,901 | 1,072,904 | 1,817,058 | ........ | 4,350,011 | 193,105 | 1,596,213 | 6,139,329 |
| ........ | 701,346 | 225,216 | 926,562 | 1,937,913 | ........ | 4,801,484 | 192,557 | 1,294,826 | 6,288,867 |
| ........ | 583,954 | 143,856 | 727,810 | 2,055,046 | ........ | 4,672,341 | 222,571 | 1,137,264 | 6,032,176 |
| ........ | 552,993 | 122,180 | 675,173 | 1,997,287 | ........ | 4,690,490 | 205,964 | 1,008,934 | 5,905,388 |
| ........ | 426,451 | 129,798 | 556,249 | 2,040,291 | ........ | 5,111,968 | 175,947 | 938,769 | 6,226,684 |
| ........ | 399,327 | 111,675 | [b] 512,162 | [c] 2,810,541 | ........ | 4,965,879 | 199,505 | 1,019,272 | 7,188,037 |
| ........ | 119,721 | 60,707 | [b] 492,746 | [c] 3,049,509 | ........ | [d] 4,624,599 | 203,527 | 632,752 | [e] 7,360,336 |
| 585,001 | 14,492,892 | 4,662,996 | 20,054,367 | 33,019,630 | 1,475,969 | 108,850,245 | 19,292,226 | 29,023,082 | 160,038,392 |

[b] Includes 312,318 tons from the Western Maryland Railroad in 1907.

[c] Includes 1,587,140 tons from the Western Maryland Railroad in 1907.

[d] Includes 297,028 tons used on line of Cumberland and Pennsylvania Railroad and its branches, and at Cumberland and Piedmont; also 339,391 tons used by the Baltimore and Ohio Railroad Company in locomotives, rolling mills, etc.

[e] Includes 1,899,458 tons from the Western Maryland Railroad in 1907.

The estimated supply of coal contained in an area of 455 square miles was 8,044,000,000 tons, from which the total production to the close of 1907 amounted to 147,606,548 short tons, representing an exhaustion, including waste, of 221,000,000 tons, or not quite 3 per cent of the original estimated contents of the Maryland coal fields.[a] Deducting the total exhaustion from the original supply, it is found that there still remain in the coal fields of Maryland, at the close of 1907, 7,823,000,000 tons, which is 1,422 times the production of 1907 and 948 times the exhaustion represented by the output of last year.

## MICHIGAN.

Total production in 1907, 2,035,858 short tons; spot value, $3,660,833.

Compared with 1906, the coal production of Michigan in 1907 showed an increase of 689,520 short tons, or 51 per cent, in quantity, and of $1,233,429 in value, the percentage of increase in value being the same as that of the increase in production. This exceptionally large percentage of increase was due in part to the fact that in 1906 3,340, or 84 per cent, of the men employed in the coal mines of Michigan were idle for an average of 88 days each during the period of suspension of operations, which began on the 1st of April. The total time lost by this suspension was equivalent to 43 per cent of the total time worked, and as the result of this idleness the coal production of the State decreased 126,873 short tons, as compared with the production of 1905. In 1907, however, the loss of time by labor disaffection was confined to one mine in which 265 men were employed, and this strike lasted only 5 days, the loss of time being insignificant.

During 1907 there were 3,982 men employed for an average of 234 days, the number of men, the average number of days worked, and the total production in 1907 all being the largest ever recorded. Previous to 1907 the largest tonnage was made in 1905, the production in that year having been 1,473,211 short tons, compared with which the production in 1907 showed an increase of 562,647 short tons, or 38.19 per cent. The year 1907 recorded also the largest average production of coal per man employed, the average per man for the year having been 511 tons, against 339 tons in 1906 and 398.6 tons in 1905, and the average production per man per day having been 2.19 tons, against 1.96 tons in 1906 and 2.14 in 1905. Practically all of the coal mines of Michigan are worked during an 8-hour day.

During 1907 there were 103 machines reported as used in the Michigan coal mines, the machine-mined product having amounted to 606,718 short tons, or 29.8 per cent of the total. In 1906, with 110 machines reported in use, the machine-mined product amounted to 417,073 tons. Of the machines in use in 1907, 59 were of the pick or puncher type, 42 were chain-breast machines, 1 was a long-wall, and 1 a pick shearing machine.

Mr. W. J. McLeod, the Michigan commissioner of labor and industrial statistics, reports that in 1907 there were 54 accidents in the coal mines of that State. Of these, 7 were fatal and 47 nonfatal. Of the 7 deaths, 4 were due to falls of roof or coal, 2 to powder explosions, and 1 to an explosion of gas or dust. Of the 47 nonfatal accidents, 26 were due to falls of roof or coal, 3 occurred in or about the shafts, and 18 were due to miscellaneous causes. The death rate per 1,000 employees was 1.76 in 1907 against 1.51 in 1906, the records in both years being exceptionally gratifying, While the death rate per 1,000 men employed was slightly higher in 1907 than in the preceding year, the quantity of coal mined in 1907 for each life lost was 290,837 tons, against 224,398 tons in 1906.

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[a] Coal Fields of the United States, by Marius R. Campbell, U. S. Geol. Survey, 1908.

The statistics of the production of coal in Michigan, by counties, during 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Michigan in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Bay | 423,697 | 40,508 | 17,193 | 481,398 | $860,371 | $1.79 | 172 | 1,413 |
| Eaton, Jackson, and Shiawassee [a] | ........ | 28,030 | 1,435 | 29,465 | 63,954 | 2.17 | 155 | 101 |
| Saginaw | 766,275 | 38,000 | 31,200 | 835,475 | 1,503,079 | 1.80 | 175 | 2,457 |
| Total | 1,189,972 | 106,538 | 49,828 | 1,346,338 | 2,427,404 | 1.80 | 173 | 3,971 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Bay | 836,060 | 77,664 | 48,850 | 962,574 | $1,659,315 | $1.72 | 226 | 1,720 |
| Eaton, Jackson, and Shiawassee [a] | ........ | 25,357 | ........ | 25,357 | 69,642 | 2.75 | 275 | 52 |
| Saginaw | 956,538 | 26,413 | 64,976 | 1,047,927 | 1,931,876 | 1.84 | 239 | 2,210 |
| Total | 1,792,598 | 129,434 | 113,826 | 2,035,858 | 3,660,833 | 1.80 | 234 | 3,982 |

[a] Including the output of small mines.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Michigan, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Bay | 325,021 | 410,634 | 544,154 | 481,398 | 962,574 | + 481,176 |
| Eaton | 7,393 | 9,057 | 4,058 | 18,507 | 5,982 | − 12,525 |
| Huron | ........ | ........ | ........ | ........ | ........ | ........ |
| Jackson | 23,307 | 16,860 | 9,196 | 8,658 | 5,645 | − 3,013 |
| Saginaw | 1,011,898 | 906,289 | 915,803 | 835,475 | 1,047,927 | + 212,452 |
| Shiawassee | ........ | ........ | ........ | [a] 2,300 | 13,730 | + 11,430 |
| Total | 1,367,619 | 1,342,840 | 1,473,211 | 1,346,338 | 2,035,858 | + 689,596 |
| Total value | $2,707,527 | $2,424,935 | $2,512,697 | $2,427,404 | $3,660,833 | +$1,233,429 |

[a] Including the output of small mines.

The coal fields of Michigan are confined entirely to the lower peninsula. An area of approximately 11,000 square miles is included within the coal-bearing formations which lie almost in the exact center of the lower peninsula. This is the only known coal field within the drainage area of the Great Lakes. The developments have been principally in the eastern portion of the field and in a line running from Bay City, on the north, to Jackson, at the southern extremity of the field. The more important mining operations have been carried on in Bay and Saginaw counties, although some coal also has been mined in Shiawassee County, near Corunna, and in Eaton, Clinton, and Jackson counties.

The coals of Michigan are, as a usual thing, of a lower grade than those coming from Ohio and Pennsylvania, with which they have to compete, but the rapid development and increase of population in the cities along Lake Michigan and Lake Huron and the Detroit and St. Clair rivers have created local markets for these coals, and the increase in production in this field during the last ten years has been unrivaled in the coal-mining industry of the United States.

The coal basin lies for the most part in a low, flat country, surrounded by a rim of higher land which rises from 1,000 to 1,500 feet above the sea level, or from 500 to 1,000 feet above the lake.

According to Prof. Alfred C. Lane, there are seven horizons where the coal occurs in workable thickness, although it was formerly supposed that there was only one workable bed in the State. Owing to the varying character of the formation and the manner in which the coal beds run together and separate, no hard-and-fast classification is made, but the following, which has been adopted by Professor Lane, is generally accepted as designating fairly the different beds, namely: Upper Rider, Upper Verne, Lower Verne, Middle Rider, Saginaw, Lower Rider, and Lower Coal. For more detailed descriptions of these beds the reader is referred to the Twenty-second Annual Report of the United States Geological Survey, Part III.

All of the coals produced in Michigan are of the dry, noncoking bituminous variety. Such coke as is manufactured in the State is from coal brought from Ohio or Pennsylvania.

Coal mining in Michigan is said to have begun in the Jackson field as early as 1835. Other mines were opened at Grand Ledge, in Clinton County, as early as 1838, but while it is known that some coal was produced here in these early years the first record of any production is that contained in the United States census report for 1860, in which year Michigan is credited with a production of 2,320 tons.

Although coal mining in Michigan began about seventy years ago, it was not until within the last eleven years that it assumed any importance as an industry. Prior to 1896 there were only four years in which the production amounted to as much as 100,000 tons. During the last decade the rapid growth of the population and manufacturing industries of the cities along the shores of Lake Huron has created a market for Michigan coals, and the production has increased rapidly, except for a setback in 1902 due to strikes among the mine workers and another in 1906 by the suspension previously referred to.

The record of production since 1860 will be found in the table on a preceding page giving the production of coal in the United States from the earliest times to the close of 1907.

Michigan's original supply of coal, according to the estimate of Mr. Campbell,[a] was 12,000,000,000 tons, contained in an area of 11,000 square miles of coal-productive territory. The production of the

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[a] Coal Fields of the United States, by Marius R. Campbell, U. S. Geol. Survey, 1908.

State at the close of 1907 amounted to 13,842,943 short tons, which, including the waste involved in the mining operations, represented an exhaustion of 21,000,000 short tons, or 0.175 of 1 per cent of the total original supply. Michigan's coal production in 1907 was 15 per cent of the aggregated output to the close of the year.

## MISSOURI.

Total production in 1907, 3,997,936 short tons; spot value, $6,540,709.

Although the production of coal in Missouri in 1907 showed an increase of 239,928 short tons, or 6.38 per cent in quantity, and of $421,976, or 6.9 per cent in value, over that of 1906, it did not reach the tonnage reported in either 1903 or 1904, the year 1903 being the banner year in the history of coal mining in the State. The mines of the State were worked steadily throughout the year and monetary conditions had seemingly no influence on either production or prices. Freight rates have been somewhat unsettled owing to the rates promulgated by the railroad and warehouse commission of the State, which failed to give satisfaction to the operators where conflicting interests were involved.

To Missouri's coal production in the last few years should be added a considerable tonnage which is credited to Kansas. The workings of the mines at Leavenworth, immediately on the Missouri River, extend under that river into Missouri territory, and, in fact, the larger part of the production of Leavenworth County, Kans., is taken from territory underlying Platte County, Mo. Mr. J. W. Marstellar states that the quantity of coal mined in Missouri, but which is included in the Kansas production, amounted in 1907 to 259,847 tons. This would make Missouri's production in 1907, 4,257,783 tons instead of 3,997,936 tons. It has been customary, however, where mine workings extend across one State line into another to credit the coal to the State in which the tipple is located, and for this reason the tonnage from Platte County, Mo., has been credited to Leavenworth County, Kans.

The increased production in 1907 was obtained with a smaller number of men, who worked, however, a greater number of days than made by the larger number of men in the preceding year. During 1906 there were 9,557 men working an average of 185 days, and producing 3,758,008 tons of coal, or 393.2 tons per man, while in 1907 8,448 men working an average of 214 days produced 3,997,936 tons of coal, or 473.2 tons per man.

In 1906 the average daily production per man was 2.13 tons, while in 1907 it was 2.21 tons, from which it appears that the increased production was due to the greater number of days worked and not to any material increase in the individual productive capacity. Practically all of the coal-mining business in Missouri is conducted on the basis of the 8-hour day, 149 mines employing 8,079 men, out of a total of 8,448 in the State, having reported working 8 hours per day during 1907. These included all of the larger mines of the State.

The use of mining machines for undercutting coal in Missouri is almost entirely restricted to the thin beds, where machines of the long-wall type can be used to advantage. In 1907 there were 62 machines in use, of which 54 were long wall. The machine-mined coal amounted to 486,882 short tons, or 12.18 per cent of the total output of the State. In 1906 there were 48 machines in use, of which 44 were long wall, and the machine-mined product amounted to 419,288 tons, or 11.16 per cent of the total.

Machinery for washing coal has been installed by one company in Missouri, and in 1907 103,181 tons of coal were washed, yielding 72,227 tons of cleaned coal and 30,954 tons of refuse.

The time lost by reason of labor troubles in the coal mines of Missouri in 1907 was unimportant. There were 777 men idle owing to strikes. The average time lost by each was, however, only 11 days.

According to Mr. J. W. Marstellar, secretary of the Missouri bureau of mines, there were 8 fatal and 23 nonfatal accidents in the coal mines of the State during 1907, this being an exceptionally good record. None of the fatalities or injuries was due to gas or dust explosions. Six out of the 8 men killed and 19 out of the 23 men injured met their deaths or injuries by falls of roof or coal. One man was killed and 1 injured by powder explosions, and 1 man was killed and 1 injured by being crushed by cars. The death rate per 1,000 employees was a little less than 1, and the number of tons mined for each life lost was 499,742.

The original coal supply of Missouri, as estimated by Mr. M. R. Campbell, of the United States Geological Survey, was 40,000,000,000 short tons, included within an area of 16,700 square miles. The production of the State, according to the best records available, amounted at the close of 1907 to something over 97,500,000 tons, representing an exhaustion of approximately 146,000,000 tons, or 0.36 of 1 per cent of the estimated original supply.

The coal-mining industry of Missouri may be considered as a record of the industrial conditions entirely within the State, modified by such fluctuations as are due to variations in the weather. The market for the coal product of the State is practically confined to its borders. Missouri is surrounded by other large coal-producing States—Iowa on the north, Kansas on the west, Arkansas and Oklahoma on the south, and Illinois and Kentucky on the east—these completing a boundary which confines the Missouri product to local markets. Moreover, some of the larger cities draw their principal fuel supplies from the neighboring States, St. Louis, for instance, being chiefly supplied with coal by Illinois, while Kansas City draws its fuel largely from Kansas.

The statistics of coal production in Missouri in 1906 and 1907, by counties, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Missouri in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | |
| Adair | 426,901 | 5,222 | 9,912 | 442,035 | $642,471 | $1.45 | 131 | 1,285 |
| Audrain | 23,607 | 9,622 | 1,004 | 34,233 | 63,097 | 1.84 | 239 | 110 |
| Barton | 198,013 | 14,910 | 5,700 | 218,623 | 306,444 | 1.40 | 187 | 504 |
| Bates | 175,065 | 31,891 | 3,262 | 210,218 | 313,510 | 1.49 | 199 | 483 |
| Boone | 10,950 | 29,302 | 374 | 40,626 | 77,929 | 1.92 | 222 | 127 |
| Callaway | ........... | 41,058 | 104 | 41,162 | 75,596 | 1.84 | 251 | 100 |
| Henry | 93,757 | 20,762 | 1,160 | 115,679 | 197,204 | 1.70 | 158 | 350 |
| Lafayette | 628,892 | 41,106 | 9,681 | 679,679 | 1,277,915 | 1.88 | 200 | 2,062 |
| Linn | 74,896 | 19,281 | 1,149 | 95,326 | 207,346 | 2.18 | 204 | 345 |
| Macon | 748,589 | 7,379 | 14,316 | 770,284 | 1,149,697 | 1.49 | 188 | 1,516 |
| Putnam | 100,375 | 2,949 | 1,575 | 104,899 | 201,771 | 1.92 | 199 | 325 |
| Ralls | 17,310 | 200 | .......... | 17,510 | 31,388 | 1.79 | 218 | 55 |
| Randolph | 338,889 | 24,297 | 8,200 | 371,386 | 498,430 | 1.34 | 201 | 591 |
| Ray | 232,860 | 38,224 | 5,257 | 276,341 | 488,372 | 1.77 | 166 | 961 |
| Other counties[a] | 230,763 | 46,734 | 9,380 | 286,877 | 487,478 | 1.70 | 202 | 743 |
| Small mines | ........... | 53,130 | .......... | 53,130 | 100,085 | 1.91 | ........ | ........ |
| Total | 3,300,867 | 386,067 | 71,074 | 3,758,008 | 6,118,733 | 1.63 | 185 | 9,557 |
| **1907.** | | | | | | | | |
| Adair | 559,512 | 17,598 | 8,381 | 585,491 | $866,523 | $1.48 | 195 | 1,072 |
| Audrain | 22,403 | 15,267 | 595 | 38,265 | 71,225 | 1.86 | 211 | 127 |
| Barton | 172,616 | 16,882 | 3,920 | 193,418 | 291,356 | 1.51 | 189 | 446 |
| Bates | 80,499 | 34,486 | 300 | 115,285 | 182,317 | 1.58 | 184 | 213 |
| Boone | 11,000 | 21,634 | 400 | 33,034 | 64,593 | 1.96 | 228 | 94 |
| Callaway | 15,600 | 18,405 | 408 | 34,413 | 52,184 | 1.52 | 225 | 81 |
| Henry | 176,090 | 30,648 | 2,914 | 209,652 | 352,737 | 1.68 | 221 | 371 |
| Lafayette | 662,943 | 44,630 | 10,015 | 717,588 | 1,329,364 | 1.85 | 234 | 1,962 |
| Linn | 97,719 | 18,327 | 1,357 | 117,403 | 255,625 | 2.18 | 238 | 334 |
| Macon | 1,109,225 | 25,765 | 21,150 | 1,156,140 | 1,633,882 | 1.41 | 217 | 1,799 |
| Putnam | 50,020 | 965 | 690 | 51,675 | 105,964 | 2.05 | 150 | 244 |
| Randolph | 36,900 | 34,600 | 1,000 | 72,500 | 104,171 | 1.44 | 192 | 124 |
| Ray | 300,899 | 29,698 | 6,787 | 337,384 | 636,311 | 1.89 | 210 | 915 |
| Other counties[b] | 199,707 | 75,827 | 7,814 | 283,348 | 491,067 | 1.73 | 212 | 666 |
| Small mines | ........... | 52,340 | .......... | 52,340 | 103,390 | 1.98 | ........ | ........ |
| Total | 3,495,133 | 437,072 | 65,731 | 3,997,936 | 6,540,709 | 1.64 | 214 | 8,448 |

[a] Benton, Caldwell, Chariton, Clay, Dade, Grundy, Howard, Johnson, Livingston, Moniteau, Monroe, Morgan, Pettis, St. Clair, Schuyler, and Vernon.

[b] Benton, Caldwell, Cass, Chariton, Clay, Dade, Grundy, Howard, Johnson, Livingston, Moniteau, Monroe, Morgan, Ralls, St. Clair, Schuyler, and Vernon.

The statistics of production during the last five years, by counties, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production in Missouri, 1903-1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Adair | 526,975 | 615,607 | 603,699 | 442,035 | 585,491 | + 143,456 |
| Audrain | 26,835 | 44,179 | 53,123 | 34,233 | 38,265 | + 4,032 |
| Barton | 193,816 | 230,875 | 241,113 | 218,623 | 193,418 | − 25,205 |
| Bates | 149,963 | 139,026 | 167,872 | 210,218 | 115,285 | − 94,933 |
| Boone | 19,752 | 37,929 | 40,786 | 40,626 | 33,034 | − 7,592 |
| Caldwell | 11,485 | 15,366 | 15,000 | 14,000 | 15,000 | + 1,000 |
| Callaway | 25,837 | 12,058 | 17,306 | 41,162 | 34,413 | − 6,749 |
| Grundy | 25,565 | 15,597 | ........ | 7,990 | 11,040 | + 3,050 |
| Henry | 59,710 | 134,651 | 125,988 | 115,679 | 209,652 | + 93,973 |
| Jackson | 8,500 | 4,050 | ........ | ........ | ........ | ........ |
| Johnson | 1,458 | 1,572 | 1,712 | 2,383 | 10,543 | + 8,160 |
| Lafayette | 639,480 | 682,419 | 667,023 | 679,679 | 717,588 | + 37,909 |
| Linn | 66,319 | 111,095 | 95,175 | 95,326 | 117,403 | + 22,077 |
| Livingston | 4,095 | 2,959 | 2,825 | 2,000 | 2,010 | + 10 |
| Macon | 1,180,653 | 914,303 | 799,513 | 770,284 | 1,156,140 | + 385,856 |
| Montgomery and Morgan | 7,583 | 8,146 | ........ | ........ | ........ | ........ |
| Putnam | 112,740 | 71,266 | 79,162 | 104,899 | 51,675 | − 53,224 |
| Ralls | 17,185 | 16,572 | 14,557 | 17,510 | 12,024 | − 5,486 |
| Randolph | 604,240 | 585,135 | 491,404 | 371,386 | 72,500 | − 298,886 |
| Ray | 296,922 | 244,707 | 236,598 | 276,341 | 337,384 | + 61,043 |
| Vernon | 181,358 | 175,006 | 195,201 | 140,570 | 141,379 | + 809 |
| Other counties and small mines | 78,115 | 102,799 | 135,321 | 173,064 | 143,692 | − 29,372 |
| Total | 4,238,586 | 4,168,308 | 3,983,378 | 3,758,008 | 3,997,936 | + 239,928 |
| Total value | $6,834,297 | $6,801,751 | $6,291,661 | $6,118,733 | $6,540,709 | +$421,976 |

The coal measures of Missouri occupy the northwestern half of the State and underlie approximately 23,000 square miles, of which 17,000 are considered to be probably productive territory. The beds belong to the Pennsylvanian series of the Carboniferous and, as in Iowa, include two well-marked divisions, a lower and an upper. The lower or productive portion occupies a belt along the eastern edge of the field, and mining is confined entirely to this area. The formation consists largely of shales and sandstones, with a few thin limestones in the upper part. The coal beds are from 4 to 6 feet thick in most situations, but are patchy in distribution. The coal is of a dry, noncoking, bituminous grade. Near the edge of the field are several outliers of very thick coal, occupying erosion depressions in the underlying limestones. These have small economic importance, but have created a great deal of interest and have led to the loss of considerable money in exploration. The total thickness of the coal measures is estimated at 2,000 feet and increases from the outcrop to the northwest, in which direction the beds have a gentle dip. The productive areas of the State include: (1) The northern, occupying Putnam and adjacent counties, in which the extension of the Centerville coal of Iowa is mined. From this field comes approximately 3 per cent of the State's output. (2) The northeastern, including Macon, Randolph, and adjacent counties, in which coal is mined from the lower beds of the coal measures. Approximately 44 per cent of the State's output is derived from this district. (3) In the central district the more important mines are in Lafayette and Ray counties, and the district, as a whole, yields about 22 per cent of the output of the State. (4) The southwestern district, in which the more important mines are in Vernon County. These work in part an extension of the Cherokee coal of Kansas and in part they take coal from other beds also in the lower portion of the coal measures. The output of this district is about 5 per cent of that of the State.

As far as any records are obtainable coal mining in Missouri began in 1840, the United States census for that year recording a production of 9,972 tons. The statistics of production will be found in the table on a preceding page, giving the production of coal in the United States from the earliest times to the close of 1907.

## MONTANA.

Total production in 1907, 2,016,857 short tons; spot value, $3,907,082.

The improvement in the coal-mining conditions in Montana, noted in the report for 1906 as having followed the comparatively little change which occurred during the period from 1895 to 1905, continued during 1907, when the production for the first time in the history of the State exceeded a total of 2,000,000 tons. In addition to the actual increased production, a considerable amount of development work in new areas was inaugurated during the year and the prospects for a still larger production in 1908 are good. Compared with 1906, the coal production of Montana in 1907 showed an increase of 186,936 short tons, or 10.22 per cent in quantity, and of $666,725, or 20.58 per cent in value.

Carbon County, in which is located the Rocky Fork or Red Lodge field, is the most important in coal production, and the increase in this county in 1907 was larger than the total increase for the State. Increases were also made in Chouteau and Fergus counties, but these were more than offset by decreases in Cascade and Gallatin counties. Most of the new development work in 1907 was also done in Rocky Fork field, where the Clark Fork extension of the Great Northern Railroad has made accessible an important portion of the Bighorn Basin region. Nearly one-half of the total production, or 984,368 short tons, was mined by machines, of which 86 were in use. This machine-mined production in 1907 was slightly larger in quantity than in 1906, but the percentage of the machine-mined product to the total was somewhat less. In 1906 the tonnage won by machines was 974,306 short tons, or 53 per cent of the total.

In the mining of Montana's coal production in 1907, 2,735 men were employed, who worked an average of 268 days, as compared with 2,394 men in 1906, and 2,181 men in 1905, in both of which years the average working time was 243 days. Most of the mines of the State are operated on the basis of an 8-hour day. In some cases, where the miners worked 8 hours a day, the day men worked 10 hours, but these are considered 8-hour mines. The average production per man in 1907 was 737 tons, as against 764.4 tons in 1906 and 753.7 tons in 1905. The average daily production per man, which increased from 3.10 tons in 1905 to 3.15 tons in 1906, fell off to 2.75 tons in 1907, the decrease in the average production per man in the latter year being due, in all probability, to the greater proportion of the product which was undercut by hand.

According to Mr. Joseph B. McDermott, State mine inspector, there were 12 fatal and 52 nonfatal accidents in the coal mines of

Montana in 1907. The mines of the State were exceptionally free from gas or dust explosions, there being no fatal accidents and but 3 nonfatal accidents due to that cause in 1907. Seven of the 12 fatalities were due to falls of roof, coal, or timber; 1 was due to the victim being crushed by cars; 1 man was killed by electric wire, and 3 deaths were due to other causes. The death rate per 1,000 was 4.4, and the number of tons mined for each life lost was 168,071.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables·

*Coal production of Montana in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Carbon | 509,798 | 16,463 | 30,887 | ........ | 557,148 | $998,862 | $1.79 | 219 | 877 |
| Cascade | 986,061 | 15,066 | 26,796 | ........ | 1,027,923 | 1,664,256 | 1.62 | 277 | 971 |
| Chouteau | 2,960 | 9,245 | 100 | ........ | 12,305 | 27,602 | 2.24 | 245 | 21 |
| Fergus | 8,000 | 20,232 | 950 | ........ | 29,182 | 88,889 | 3.05 | 185 | 55 |
| Park | 25,171 | 1,026 | 7,097 | 69,045 | 102,339 | 287,520 | 2.81 | 196 | 345 |
| Other counties [a] | 89,301 | 923 | 7,897 | ........ | 98,121 | 165,218 | 1.68 | 298 | 125 |
| Small mines | ........ | 2,903 | ........ | ........ | 2,903 | 8,010 | 2.76 | ........ | ........ |
| Total | 1,621,291 | 65,858 | 73,727 | 69,045 | 1,829,921 | 3,240,357 | 1.77 | 243 | 2,394 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Carbon | 683,470 | 15,750 | 46,890 | ........ | 746,110 | $1,431,333 | $1.92 | 274 | 1,101 |
| Cascade | 980,698 | 19,710 | 25,815 | ........ | 1,026,223 | 1,724,056 | 1.68 | 260 | 1,046 |
| Chouteau | 14,500 | 9,997 | 350 | ........ | 24,847 | 71,077 | 2.86 | 202 | 59 |
| Fergus | 20,520 | 23,840 | 1,400 | ........ | 45,760 | 172,018 | 3.76 | 243 | 81 |
| Park | 34,848 | 1,492 | 5,976 | 60,239 | 102,555 | 381,940 | 3.72 | 291 | 323 |
| Other counties [b] | 59,439 | 790 | 9,103 | ........ | 69,332 | 121,080 | 1.75 | 277 | 125 |
| Small mines | ........ | 2,030 | ........ | ........ | 2,030 | 5,578 | 2.75 | ........ | ........ |
| Total | 1,793,475 | 73,609 | 89,534 | 60,239 | 2,016,857 | 3,907,082 | 1.94 | 268 | 2,735 |

[a] Deerlodge, Gallatin, and Meagher.

[b] Deerlodge and Gallatin.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with the increases and decreases in 1907, as compared with 1906:

*Production of coal in Montana, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Carbon | 589,997 | 544,976 | 588,414 | 557,148 | 746,110 | + 188,962 |
| Cascade | 733,064 | 599,158 | 826,026 | 1,027,923 | 1,026,223 | − 1,700 |
| Chouteau | 9,875 | 5,764 | 6,500 | 12,305 | 24,847 | + 12,542 |
| Fergus | 9,734 | 19,109 | 15,228 | 29,182 | 45,760 | + 16,578 |
| Gallatin | 58,696 | 109,556 | 123,006 | 97,926 | 69,257 | − 28,669 |
| Park | 86,044 | 78,646 | 81,807 | 102,339 | 102,555 | + 216 |
| Other counties and small mines | 1,400 | 1,710 | 2,851 | 3,098 | 2,105 | − 993 |
| Total | 1,488,810 | 1,358,919 | 1,643,832 | 1,829,921 | 2,016,857 | + 186,936 |
| Total value | $2,440,846 | $2,194,548 | $2,823,350 | $3,240,357 | $3,907,082 | +$666,725 |

The workable coal beds in Montana are of Cretaceous and Tertiary age. Coal formed in Cretaceous time is probably of higher grade than the later deposits, but the Tertiary beds are thicker and cover a greater area. In character the coals are bituminous, subbituminous, and lignite; some of the first-named being fair coking coals. It is estimated that within this State 34,000 square miles are underlain by coal beds of workable thickness. This productive area is included in a number of widely separated fields, the most important of which, named from east to west, are the Miles City, Bull Mountain, Lewistown, Bridger, Red Lodge, Livingston and Bozeman, and Great Falls fields. Coal is also known to occur in the southern part of Gallatin, and in Madison and Beaverhead counties, and at various other places in the western part of the State. To the north coal is also mined in the Assiniboine region.

Of the fields mentioned above, the Miles City field is a small part of a large area of coal-bearing rocks whose boundaries have not yet been determined. Coal beds extend east for at least 40 miles, west as far as Forsythe, south to the Wyoming line, and north probably to the international boundary. This field is separated from the Medora field of North Dakota by the Glendive anticline. The coal beds are thick and persistent for long distances in the upper part of the Fort Union formation, but they are exceedingly variable in thickness and workable only in limited areas in the lower part. Coal is mined for local supply at many places near Miles City, but two permanent mines supply most of the local trade.

The Bull Mountain field lies chiefly south of Musselshell River, between Roundup and Musselshell post-offices, and extends southward, including the Bull Mountains, a distance of about 25 miles. The field is estimated to cover between 500 and 600 square miles. In the mountain region 14 different beds reach a thickness of 2 feet or more. Some of these measure from 3 to 5 feet, and one, the "Mammoth Seam," is from 8 to 15 feet thick.

An eastern extension of the Great Falls field is in the vicinity of Lewistown, but there is much less development than in the area to the west.

The Bridger field, in the valley of Clark Fork, contains one bed of coal which has been mined near the town of Bridger for a number of years. The area of this coal field is probably not very extensive.

The Red Lodge field, in Carbon County, contains 7 different beds of coal varying in thickness from 3 to 12 feet and covering an area estimated to be 32 square miles. Several extensive mines are located at Red Lodge and Bear Creek. At the present time about 1,000 miners are employed in this field.

Some coal is mined about Livingston and Bozeman. The coal-bearing formation in the southwestern portion of Yellowstone and northeastern portion of Sweetgrass counties and extending westward around the north end of the Crazy Mountains does not carry any coal beds of commercial value.

The Great Falls field, in Cascade County, is one of the most important in the State. Extensive mines are located at Sand Coulee and Stockett, and, as shown in the foregoing table, 50 per cent of the total production of the State in 1907 was credited to this county.

According to the estimates of Mr. M. R. Campbell, of the U. S. Geological Survey, the original coal supply of Montana was 303,060,000,000 short tons, from which there had been mined at the close of 1907 approximately 24,740,000 tons, representing an exhaustion, including the waste in mining, of about 37,000,000 tons, or 0.012 per cent of the original supply. The coal-mining industry of Montana, according to the best records available, began in 1880, in which year, according to the United States census, the production amounted to 224 short tons. It was not until 1889, however, that the industry assumed any importance. The production increased nearly 800 per cent (from 41,467 short tons in 1888 to 363,301 short tons in 1889). During the next six years development advanced rapidly, until in 1895 it exceeded 1,500,000 tons. From 1895 to 1905 the production remained practically steady, ranging from a minimum of 1,358,919 tons in 1904 to a maximum of 1,661,775 tons in 1900. It increased to 1,829,921 tons in 1906, and exceeded, for the first time, 2,000,000 tons in 1907.

The annual production from 1880 to 1907 is shown in the table on a preceding page giving the history of the production of coal in the United States from the time of earliest record to the close of 1907.

## NEBRASKA.

At spasmodic intervals a small quantity of coal has been reported in Nebraska, and in 1907, 750 short tons were reported as having been produced in Nemaha County of this State. It was used entirely for local consumption.

## NEVADA.

A small subbituminous, or black lignite, area occurs in Esmeralda County, Nev., from which there was produced in 1906, 800 short tons. In 1907 the production amounted to only 330 tons.

## NEW MEXICO.

Total production in 1907, 2,628,959 short tons; spot value, $3,832,128.

At no time in its history has the coal-mining industry of New Mexico exhibited such a year of activity and prosperity as 1907. In addition to the fact that the production increased from 1,964,713 short tons in 1906 to 2,628,959 tons in 1907, a gain of 664,246 tons, or 33.81 per cent, there was an advance in the average price per ton of from $1.34 to $1.46, and the total value increased from $2,638,986 to $3,832,128, a gain of $1,193,142, or 45.21 per cent.

In the report for 1906 attention was called to the increase in the quantity of New Mexico coal used in the manufacture of coke, there having been during that year an increase of 127,396 short tons, or over 40 per cent of the total increase in production, which was used in the manufacture of coke. The amount of coal made into coke in 1906 was 289,107 tons, against 161,711 tons in 1905. In 1907 the quantity of coal made into coke was 498,279 tons, an increase of 209,172 tons, or 72 per cent, over 1906. All of the coal made into coke is mined in Colfax County, the most important coal-producing county in the Territory. This county alone produced in 1907 1,844,550 tons, against 1,292,241 tons in 1906, a gain of 552,309 tons. McKinley County increased its production from 560,917 tons to 629,821 tons. These two counties produced over 90 per cent of the total output of the Territory.

There was throughout the entire year a shortage in the supply of labor and also of transportation facilities which, it is claimed, curtailed the production at least 30 per cent. It is doubtful, however, notwithstanding the unprecedented demand for coal, that if the supply of labor and transportation facilities had been amply sufficient, the market could have absorbed a further increase of over 780,000 tons. The effect of the financial situation was not felt in New Mexico until late in the year and had no appreciable influence upon the coal-mining industry.

Many important improvements in the equipment and development of the coal mines of the Territory were made during 1907, putting them into condition for a considerably increased production in the future, but on account of the closing of the copper and other metal mines of the Rocky Mountain region in the last two months of 1907 the indications were that there would be no difficulty in supplying the demand for coal during 1908.

The coal mines of New Mexico gave employment in 1907 to 2,970 men, who worked an average of 269 days, against 2,070 men for an average of 242 days in 1906.

Most of the mines of the Territory worked 10 hours a day, 14 mines, with a total of 2,584 men and representing almost 90 per cent of the total number of men employed, having reported 10 hours as the length of the working day. The productive capacity of the miners in New Mexico compares favorably with that of the miners in any of the coal-producing States, although there was a falling off in the average tonnage per man in 1907, as compared with 1906. The average production per man in 1907 was 885.2 tons, against 949.1 tons in 1906. The average daily production per man decreased from 3.92 tons to 3.29 tons. The decrease in efficiency was probably due to the large number of new and consequently less experienced men in the coal mines of the Territory. According to Mr. Jo E. Sheridan, the Territorial mine inspector, the shut down of the copper mines in Arizona caused many of the copper miners to seek employment in the coal mines, and as it does not require a long apprenticeship for a quartz miner to become a good coal miner, and as he can make better pay in the coal than in the quartz mines, Mr. Sheridan is of the opinion that many of the men will remain at the coal mines even after the quartz mines have resumed operations. It is therefore to be expected that the lower efficiency record in 1907 will not be repeated in 1908.

Mr. Sheridan reports that there were 34 men killed in the coal mines of New Mexico in 1907. The law does not require the operators to report nonfatal accidents. Of the 34 fatalities, 11 were due to gas or dust explosions, 13 to falls of roof or coal, 6 men were caught by cars and motors, 3 were suffocated in mine fires, and 1 man was struck by timbers while riding on a car. The death rate per 1,000 was 11.45, and the number of tons of coal mined for each life lost was 77,322. The record for 1907 shows an unfortunate comparison with the preceding year, when only 9 fatalities were reported, the death rate per 1,000 was 3.82, and the number of tons mined for each life lost was 199,359.

During 1905 and 1906 there were no mining machines reported as having been used in the undercutting of coal in the Territory of New Mexico. In 1907 three machines were reported as in use, and by them 11,615 tons of coal were mined.

The statistics of production, by counties, during 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of New Mexico in 1906 and 1907, by counties, in short tons.*

**1906.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Colfax | 962,345 | 21,057 | 19,732 | 289,107 | 1,292,241 | $1,576,636 | $1.22 | 240 | 1,253 |
| McKinley | 542,407 | 4,984 | 13,526 | .......... | 560,917 | 807,067 | 1.44 | 261 | 602 |
| Other counties [a] | 101,046 | 7,156 | 1,448 | .......... | 109,650 | 251,068 | 2.29 | 195 | 215 |
| Small mines | .......... | 1,905 | .......... | .......... | 1,905 | 4,215 | 2.21 | .......... | .......... |
| Total | 1,605,798 | 35,102 | 34,706 | 289,107 | 1,964,713 | 2,638,986 | 1.34 | 242 | 2,070 |

**1907.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Colfax | 1,296,253 | 19,418 | 30,600 | 498,279 | 1,844,550 | $2,373,502 | $1.29 | 281 | 1,792 |
| McKinley | 609,475 | 2,817 | 17,529 | .......... | 629,821 | 1,065,810 | 1.69 | 254 | 719 |
| Other counties [b] | 132,747 | 13,170 | 7,871 | .......... | 153,788 | 391,316 | 2.54 | 250 | 459 |
| Small mines | .......... | 800 | .......... | .......... | 800 | 1,500 | 1.88 | .......... | .......... |
| Total | 2,038,475 | 36,205 | 56,000 | 498,279 | 2,628,959 | 3,832,128 | 1.46 | 269 | 2,970 |

[a] Johnson, Rio Arriba, Sandoval, San Juan, Santa Fe, and Socorro.
[b] Lincoln, Rio Arriba, Sandoval, San Juan, Sante Fe, and Socorro.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907, as compared with 1906, are shown in the following table:

*Coal production of New Mexico, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Colfax | 723,786 | 788,955 | 1,031,829 | 1,292,241 | 1,844,550 | + 552,309 |
| Lincoln | 97,229 | 70,964 | 19,143 | .......... | 1,691 | + 1,691 |
| McKinley | 569,362 | 441,865 | 480,490 | 560,917 | 629,821 | + 68,904 |
| Rio Arriba | 35,500 | 40,825 | 31,700 | 43,600 | 34,450 | − 9,150 |
| Santa Fe | 75,535 | 60,090 | 69,832 | 3,938 | 31,952 | + 28,014 |
| Other counties | 40,369 | 49,626 | 16,939 | 64,017 | 86,495 | + 22,478 |
| Total | 1,541,781 | 1,452,325 | 1,649,933 | 1,964,713 | 2,628,959 | + 664,246 |
| Total value | $2,105,785 | $1,904,499 | $2,190,231 | $2,638,986 | $3,832,128 | +$1,193,142 |

Like most of the coals of the Rocky Mountain region, the coals of New Mexico are of Cretaceous age and vary from lignite to anthracite. The anthracite areas are, however, those in which the coal has been locally metamorphosed by volcanic intrusion. The production of anthracite from the Territory does not amount to 50,000 tons a year. As in Colorado, the known producing areas of New Mexico occur in somewhat widely separated localities. The Raton field, in Colfax County, which is the southern end of the same field in Colorado; the Durango-Gallup field, which extends from Durango southward through Rio Arriba, San Juan, and McKinley counties to Gallup and Mount Taylor, and embraces a number of districts, of which the Gallup, the Monero-Lumberton, and the Fruitland are the principal producers; the Los Cerrillos and Tejon areas, in Santa Fe County, and the Whiteoaks field, in Lincoln County, make up the principal producing areas in the Territory. A considerable amount of development work is now being carried on in the Raton district, and this is expected to prove of decided importance in the future. Some of the coals of New Mexico are true coking coals, and a considerable quantity of coke is made each year. The majority of the coals of the Territory, however, belong to the "black lignite," or subbituminous class.

At the present time this field is attracting a great deal of attention, and it seems probable that extensive developments will be undertaken in the near future. Already the Denver and Rio Grande Railroad has built a standard-gage line southwest from Durango, Colo., to Farmington, N. Mex., and there are persistent rumors that the Southern Pacific will build north through this field to Denver. In the Raton district new areas have been recently opened up by the building of the St. Louis, Rocky Mountain and Pacific Railway. This line has been surveyed westward toward the Durango-Gallup field.

A great quantity of the coke demanded by the smelters of metallic ores in the southern part of the Territories of New Mexico and Arizona is shipped from distant points, such as Pennsylvania and West Virginia, and even from foreign countries by way of San Francisco. This is significant of the fact that the production of coke in the Southwest is far below the demand.

During 1905 a geological survey was conducted around the east side of the Durango-Gallup coal field from Durango, Colo., southward and westward to Gallup, N. Mex. The following year a survey was made around the opposite side of the basin from Durango, Colo., southward by way of Gallup to Zuni Salt Lake, New Mexico. This is the largest coal area of the Territory, and comprises about 13,000 square miles; about one-seventh of the field lies in Colorado and the remainder in New Mexico. More than half of this immense field consists of workable coal lands, and the details of the surveys are published in Bulletins No. 285 and No. 316 of the United States Geological Survey.

The first record of coal production in New Mexico is that contained in the initial issue of the volume Mineral Resources of the United States, which covered the calendar year 1882. In that year the reported output was 157,092 tons, or about 6 per cent of what it was in 1907, indicating that in 26 years the coal production of New Mexico has increased more than 16 times. The annual production since 1882 is given on a preceding page, in the table showing the production of coal in the United States from the earliest times to the close of 1907. In this period the total production has amounted to 22,325,432 short tons, which, including mining and other loss, represents a total exhaustion of about 33,000,000 tons.

According to the estimate of Mr. M. R. Campbell, the original coal supply in the Territory of New Mexico was 163,780,000,000 tons, so that the exhaustion to date represents approximately 0.02 of 1 per cent of the original supply. The production in 1907 was equal to nearly 12 per cent of the entire production to the close of that year, while the coal left in the ground is nearly 65,000 times the production in 1907 and over 40,000 times the exhaustion represented by that production.

## NORTH CAROLINA.

No coal production was reported from North Carolina in either 1906 or 1907. The output from the Cumnock mines, which had decreased from 23,000 tons in 1902 to 17,309 tons in 1903, 7,000 tons in 1904, and 1,557 tons in 1905, ceased entirely in 1906.

There are two areas in North Carolina in which coal occurs. Both of these are found in the Triassic formation, and are of the same geologic age as the Richmond coal basin of Virginia. The two areas are known as the Deep River and the Dan River fields, being named from the two rivers which drain them. The only productive beds in recent years are those in the Deep River district, in Chatham and Moore counties.

The production during the five years from 1901 to 1905, inclusive, with the distribution of the product for consumption, will be found in the following table:

*Distribution of the coal product of North Carolina, 1901–1905, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| 1901 | 10,000 | .......... | 2,000 | 12,000 | $15,000 | $1.25 | 300 | 25 |
| 1902 | 20,400 | 100 | 2,500 | 23,000 | 34,500 | 1.50 | 285 | 40 |
| 1903 | 14,429 | 87 | 2,793 | 17,309 | 25,300 | 1.47 | 264 | 49 |
| 1904 | 4,600 | 300 | 2,100 | 7,000 | 10,500 | 1.50 | 240 | 25 |
| 1905 | 461 | 1,096 | .......... | 1,557 | 2,336 | 1.50 | 60 | 15 |

The United States census of 1840 stated that a production of 3 tons was obtained from North Carolina in that year. There is no evidence of any other production prior to the civil war, when the necessities of the Confederate government were partly relieved by coal obtained from this region. After the war the production fell off for several years, and from 1874 to 1879 none was reported from this area. The Cumnock or Egypt mines were reopened in 1889, and were producing each year from that time until 1906.

## NORTH DAKOTA.

Total production in 1907, 347,760 short tons; spot value, $560,199.

All of the mineral fuel produced in North Dakota is brown lignite, extensive beds of which underlie the greater part of the western half of the State. This lignite is not a high-grade fuel for heating purposes, and until 1906 such mining operations as were carried on were for the purpose of supplying ranchmen who had no other fuel. Since that time, however, production has been stimulated somewhat through the act of the North Dakota legislature which compelled the use of the North Dakota lignite in all State buildings and institutions. It is possible that the distress among the inhabitants of the State during the severe winter of 1906 and 1907 was partly due to this legislation, as on account of the compulsory use of this fuel in the State institutions the dealers in coal did not have a large enough supply to meet the requirements occasioned by the severe weather of that winter.

It has been said that lignite burns without heat, and while there seems to be excellent promise of utilizing this North Dakota product for the generation of power through gas producers, there may be some question as to the wisdom of compelling its use for heating purposes.

Stimulated by the severe winter of 1906 and 1907, the production of lignite in North Dakota in 1907 showed an increase of 42,071 short tons, or 13.76 per cent in quantity, over 1906, with an increase of $108,817, or 24.11 per cent, in value.

The number of men employed in the lignite mines of the State in 1907 was 562, who worked for an average of 223 days, as compared with 488 men for an average of 209 days in 1906. The average production per man was 619 tons in 1907, against 626.4 tons in 1906, while the daily production for each employee decreased from 3 tons in 1906 to 2.78 tons in 1907.

The number of mining machines in use increased from 9 in 1905 to 11 in 1906 and 12 in 1907, while the machine-mined product, which decreased from 97,789 tons in 1905 to 97,035 tons in 1906, increased to 136,700 tons in 1907.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of North Dakota in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | |
| Morton | 16,289 | 6,855 | 50 | 23,194 | $37,099 | $1.60 | 175 | 50 |
| Stark | 56,535 | 6,250 | 1,000 | 63,785 | 80,900 | 1.27 | 254 | 74 |
| Ward | 38,820 | 79,704 | 2,438 | 120,962 | 202,402 | 1.67 | 201 | 195 |
| Other counties [a] | 78,095 | 17,784 | 824 | 96,703 | 129,058 | 1.33 | 249 | 169 |
| Small mines | .......... | 1,045 | .......... | 1,045 | 1,923 | 1.84 | .......... | .......... |
| Total | 189,739 | 111,638 | 4,312 | 305,689 | 451,382 | 1.54 | 209 | 488 |
| **1907.** | | | | | | | | |
| Morton | 5,000 | 5,640 | 50 | 10,690 | $15,905 | $1.49 | 125 | 37 |
| Stark | 55,383 | 12,180 | 4,000 | 71,563 | 99,797 | 1.39 | 250 | 114 |
| Ward | 46,208 | 76,156 | 1,850 | 124,214 | 241,250 | 1.90 | 203 | 269 |
| Other counties [a] | 111,717 | 22,055 | 5,450 | 139,222 | 200,621 | 1.44 | 267 | 142 |
| Small mines | .......... | 2,071 | .......... | 2,071 | 2,626 | 1.27 | .......... | .......... |
| Total | 218,308 | 118,102 | 11,350 | 347,760 | 560,199 | 1.61 | 223 | 562 |

[a] Burleigh, Emmons, McLean, and Williams.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907, as compared with 1906, are shown in the following table:

*Coal production of North Dakota, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Burleigh | 104,835 | 92,970 | 74,357 | 83,267 | 123,662 | + 40,395 |
| McLean | 3,925 | 13,100 | 15,515 | 8,005 | 9,660 | + 1,655 |
| Morton | 13,500 | 10,663 | 26,100 | 23,194 | 10,690 | − 12,504 |
| Stark | 46,764 | 52,744 | 49,417 | 63,785 | 71,563 | + 7,778 |
| Ward | 98,081 | 87,766 | 137,542 | 120,962 | 124,214 | + 3,252 |
| Williams | 8,935 | 9,185 | 9,268 | 4,431 | 5,400 | + 969 |
| Emmons<br>Mercer | ........ | 2,100 | 4,000 | ........ | ........ | ........ |
| Small mines | 2,605 | 3,400 | 1,343 | [a] 2,045 | [a] 2,571 | + 526 |
| Total | 278,645 | 271,928 | 317,542 | 305,689 | 347,760 | + 42,071 |
| Total value | $418,005 | $389,052 | $424,778 | $451,382 | $560,199 | + $108,817 |

[a] Includes Emmons County.

Almost the entire western half of North Dakota is underlain by beds of lignite, which vary in thickness from a few inches to 33 feet. While in many cases the lignite is local in its development and can be identified for not more than 2 or 3 square miles of territory, there are cases in which the extent of the beds is much greater. Detailed investigations of the lignite in the Glendive-Medora coal field of eastern Montana and western North Dakota has proved conclusively that the individual beds could be traced much farther than was formerly supposed. Mr. Carl D. Smith reports one of these beds which was actually traced a distance of 12 miles, showing workable thickness throughout. Other beds have been correlated over the field for great distances. The State geologist of North Dakota reports one bed as having been traced by him for a distance of 24 miles, and the idea that all of the beds were local in character was probably given currency through lack of detailed work, and in previous volumes of Mineral Resources of the United States it has been stated that cases were rare in which an individual bed could be traced or identified over more than 2 or 3 miles of territory.

According to the reports of the State Geological Survey, 97 townships contain in some part of their area at least one bed of lignite 7 feet or more in thickness, while at least 100 other townships contain beds from 4 to 7 feet thick. The lignite is generally well exposed along such streams as Big and Little Missouri, Knife, Heart, and Mouse rivers. Mining is carried on to some extent at most of the towns along the Northern Pacific Railway west of Mandan, on the Minneapolis, St. Paul and Sault Ste. Marie Railway in the Mouse River Valley, and also north of Bismarck, and to a small extent along the Great Northern Railway near Minot and Williston. The total area underlain by lignite-bearing beds is estimated to be 35,000 square miles.

The lignite is brown and generally woody, and as it comes from the mine contains about 40 per cent of moisture. Upon exposure to the atmosphere the lignite loses some of this moisture, and as a result it "slacks" or crumbles to pieces. If exposed indefinitely it breaks down to a fine powder, with probably considerable oxidation and loss of volatile combustible matter.

On account of its heavy percentage of moisture and rapid disintegration on exposure it does not stand transportation well, and consequently its field of usefulness is limited. So far its principal use has been to supply fuel to the settlers on the treeless plains in the western part of the State, and for this purpose it has been mined in a crude way in almost every county in the lignite-bearing area. Commercial mines are situated on the lines of railway, and these supply the towns of the State with fuel for domestic purposes and for use under steam boilers. On account, however, of the large percentage of moisture contained in the lignite it has difficulty in meeting competition with Pennsylvania and West Virginia coals, which find their way into this country via the Great Lakes.

Lignite has doubtless been mined and used in North Dakota by ranchmen and others since the time when North Dakota was a Territory, but it was not until 1884 that any record of production was obtained. This was published in the volume of Mineral Resources for that year. The production since 1884 is given in the table on a preceding page showing the production of coal in the United States from the earliest times to the close of 1907.

## OHIO.

Total production in 1907, 32,142,419 short tons; spot value, $35,324,746.

Early in 1908 Mr. George Harrison, chief inspector of mines for the State of Ohio, estimated that the total production of the State in 1907 had been about 30,000,000 tons, which would have been equivalent to an increase of something less than 10 per cent over that of 1906. The complete statistics for 1907 show that Mr. Harrison's estimate was conservative, as the actual increase in production was more than 2,000,000 short tons in excess of his estimate, and the production for the year showed an increase of 4,410,779 short tons, or 15.91 per cent in quantity, and of $4,978,166, or 16.4 per cent in value over that of 1906. As was general throughout the coal-mining States in 1907, the industry in Ohio was not affected by labor troubles or strikes of any consequence tending to materially curtail the output. Mining in the Hocking Valley district was interrupted for a while during the spring months by disastrous floods, but this interruption did not result in serious loss to the mines. The car supply was more satisfactory than in some of the other States, the transportation companies seeming to meet for the most part the demands made upon them. The average prices throughout the year were satisfactory to the operators.

Of the 29 counties in the State in which coal was produced in 1907, 19 reported an increased production during the year, and in 10 the production decreased. The principal increases were in Belmont County (1,941,323 short tons), Guernsey (697,083 tons), Athens (559,620 tons), Tuscarawas (383,648 tons), and Perry (343,559 tons). The effects of the floods in the Hocking Valley region are shown by the fact that Hocking County's production decreased

144,531 tons. This was the largest decrease in any one county in the State. The next largest decreases were in Meigs County (98,932 tons) and in the combined production of Noble and Scioto counties (86,555 tons).

The number of men employed in the coal mines of Ohio increased from 45,438 in 1906 to 46,833 in 1907. The average number of working days in 1906, owing to the suspension of work pending the arrangement of the wage scale, was only 167, while in 1907 the average working time was 199 days. The average production per man shows that while the working time was reduced in 1906, the men worked with greater energy during the time the mines were operated, the average daily production per man having increased from 3.35 in 1905 to 3.65 in 1906, and fell off in 1907 to 3.45 tons. For the year 1907, however, there was a larger production per man than in either of the preceding years, this average amounting to 686 tons in 1907, as compared with 610.3 tons in 1906 and 588.9 tons in 1905. As in the other States where coal mining is carried on under agreements with the United Mine Workers of America, the mines of Ohio, with only a few exceptions, were operated 8 hours a day. In 1907 there were 490 mines, employing 44,733 men out of a total for the State of 46,833, which were operated on the 8-hour basis. There were 4 mines, employing 53 men, that worked 9 hours, and 2 mines, employing 31 men, that worked 10 hours. There were 2,016 men whose time was not reported.

Ohio continues to lead all other coal-producing Sates in the percentage of the total product which is mined by the use of machines. The statistics of 1907 show that there were 1,328 machines in use, while the machine-mined product amounted to 24,843,616 short tons, or 77.29 per cent of the total output. In 1906 there were 1,255 machines in use, and the machine-mined product amounted to 20,004,416 short tons, or 72.14 per cent of the total output, while in 1905 there were 1,041 machines in use, by which 16,888,417 short tons of coal, or 66.1 per cent of the total, were mined. Of these machines 109 were of the pick or puncher type, 1,213 were chain breast, and 6 were long wall.

The casualty statistics for Ohio, as reported by Mr. George Harrison, the State mine inspector, show that there were 153 men killed and 662 injured in the coal mines of Ohio during 1907. There were only 3 deaths due to explosions of gas; 94 men were killed by falls of roof; 3 by falls of coal; 16 by mine cars; 6 by motors and mining machines; 2 by premature explosions; 11 by electric wires, and 18 by other causes. The death rate per 1,000 employees was 3.27, the number of tons of coal mined for each life lost being 210,081.

The strike records of 1907 show that during the year 6,367 men were idle for an average of 17 days, the total time lost not being sufficient to materially affect the production.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Ohio in 1906 and 1907, by counties, in short tons.*

### 1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Athens | 3,892,410 | 28,121 | 82,543 | ........ | 4,003,074 | $4,334,369 | $1.08 | 161 | 6,914 |
| Belmont | 4,032,647 | 198,201 | 36,017 | ........ | 4,266,865 | 4,046,491 | .95 | 173 | 6,490 |
| Carroll | 151,868 | 38,535 | 5,310 | ........ | 195,713 | 237,544 | 1.21 | 154 | 483 |
| Columbiana | 546,915 | 50,375 | 10,127 | ........ | 607,417 | 681,163 | 1.12 | 176 | 1,306 |
| Coshocton | 334,398 | 29,722 | 3,480 | ........ | 367,600 | 449,168 | 1.22 | 181 | 665 |
| Gallia | 41,205 | 6,130 | 160 | ........ | 47,495 | 52,767 | 1.11 | 214 | 111 |
| Guernsey | 3,216,485 | 11,542 | 45,811 | ........ | 3,273,838 | 3,157,251 | .96 | 190 | 3,700 |
| Harrison | 263,494 | 12,187 | 4,551 | ........ | 280,232 | 268,619 | .91 | 154 | 490 |
| Hocking | 1,763,255 | 17,780 | 12,077 | ........ | 1,793,112 | 1,992,363 | 1.11 | 179 | 2,917 |
| Holmes | 5,000 | 34,465 | ........ | ........ | 39,465 | 65,556 | 1.66 | 194 | 69 |
| Jackson | 1,256,084 | 86,397 | 27,319 | ........ | 1,369,800 | 2,172,237 | 1.59 | 174 | 3,332 |
| Jefferson | 4,185,476 | 266,746 | 61,174 | 2,024 | 4,515,420 | 4,508,922 | 1.00 | 164 | 5,241 |
| Lawrence | 140,672 | 36,073 | 400 | ........ | 177,145 | 240,040 | 1.36 | 162 | 484 |
| Mahoning | 78,400 | 37,164 | 2,425 | ........ | 117,989 | 173,411 | 1.47 | 211 | 248 |
| Medina | 59,650 | 12,674 | 795 | ........ | 73,119 | 99,636 | 1.36 | 225 | 159 |
| Meigs | 365,453 | 60,177 | 3,805 | ........ | 429,435 | 467,518 | 1.09 | 245 | 686 |
| Muskingum | 245,930 | 35,518 | 900 | ........ | 282,348 | 293,354 | 1.04 | 182 | 493 |
| Perry | 2,468,704 | 48,138 | 40,746 | ........ | 2,557,588 | 2,841,113 | 1.11 | 127 | 5,532 |
| Scioto | 6,900 | 1,200 | 300 | ........ | 8,400 | 12,036 | 1.43 | 108 | 48 |
| Stark | 431,554 | 105,985 | 42,101 | ........ | 579,640 | 1,072,243 | 1.85 | 143 | 1,571 |
| Summit | 88,736 | 9,645 | 5,835 | ........ | 104,216 | 186,671 | 1.79 | 139 | 322 |
| Tuscarawas | 1,258,124 | 139,199 | 16,428 | ........ | 1,413,751 | 1,493,903 | 1.06 | 182 | 2,271 |
| Vinton | 182,784 | 20,725 | 7,475 | ........ | 210,984 | 246,590 | 1.17 | 167 | 432 |
| Wayne | 201,031 | 11,000 | 3,000 | ........ | 215,031 | 354,975 | 1.65 | 203 | 469 |
| Other counties [a] and small mines | 697,997 | 94,651 | 9,315 | ........ | 801,963 | 898,640 | 1.12 | 165 | 1,005 |
| Total | 25,915,172 | 1,392,350 | 422,094 | 2,024 | 27,731,640 | 30,346,580 | 1.09 | 167 | 45,438 |

### 1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Athens | 4,439,889 | 28,400 | 93,905 | 500 | 4,562,694 | $5,097,203 | $1.12 | 159 | 7,473 |
| Belmont | 5,774,471 | 370,299 | 63,418 | ........ | 6,208,188 | 6,013,317 | .97 | 228 | 7,482 |
| Carroll | 274,015 | 81,101 | 11,946 | ........ | 367,062 | 385,538 | 1.05 | 207 | 615 |
| Columbiana | 595,959 | 103,191 | 10,365 | ........ | 709,515 | 847,851 | 1.19 | 209 | 1,382 |
| Coshocton | 363,276 | 35,669 | 4,070 | ........ | 403,015 | 501,978 | 1.25 | 217 | 623 |
| Gallia | 29,660 | 5,535 | ........ | ........ | 35,195 | 39,434 | 1.12 | 182 | 69 |
| Guernsey | 3,860,211 | 19,287 | 91,423 | ........ | 3,970,921 | 3,661,399 | .92 | 221 | 4,466 |
| Harrison | 462,062 | 30,429 | 6,869 | ........ | 499,360 | 479,717 | .96 | 158 | 637 |
| Hocking | 1,619,118 | 18,414 | 11,049 | ........ | 1,648,581 | 1,869,308 | 1.13 | 167 | 2,584 |
| Holmes | 8,150 | 14,015 | ........ | ........ | 22,165 | 30,071 | 1.36 | 181 | 53 |
| Jackson | 1,191,903 | 60,385 | 32,589 | ........ | 1,284,877 | 2,154,150 | 1.68 | 182 | 2,760 |
| Jefferson | 4,180,890 | 268,303 | 78,013 | 800 | 4,528,006 | 4,711,020 | 1.04 | 223 | 5,702 |
| Lawrence | 173,306 | 65,645 | 4,076 | ........ | 243,027 | 315,003 | 1.30 | 193 | 563 |
| Mahoning | 58,083 | 33,602 | 2,650 | ........ | 94,335 | 144,478 | 1.53 | 195 | 208 |
| Medina | 30,873 | 14,394 | 804 | ........ | 46,071 | 70,713 | 1.53 | 172 | 112 |
| Meigs | 288,934 | 40,041 | 1,528 | ........ | 330,503 | 380,425 | 1.15 | 167 | 782 |
| Muskingum | 328,929 | 83,862 | 1,330 | ........ | 414,121 | 431,266 | 1.04 | 197 | 631 |
| Perry | 2,777,863 | 62,899 | 60,385 | ........ | 2,901,147 | 3,179,928 | 1.10 | 193 | 4,560 |
| Stark | 540,312 | 126,492 | 21,062 | ........ | 687,866 | 1,290,401 | 1.88 | 164 | 1,417 |
| Summit | 81,523 | 16,513 | 6,200 | ........ | 104,236 | 199,877 | 1.92 | 184 | 350 |
| Tuscarawas | 1,608,469 | 160,704 | 28,226 | ........ | 1,797,399 | 1,914,435 | 1.07 | 219 | 2,404 |
| Vinton | 160,623 | 89,446 | 4,460 | ........ | 254,529 | 302,242 | 1.19 | 178 | 524 |
| Wayne | 175,905 | 7,755 | 1,600 | ........ | 185,260 | 325,808 | 1.76 | 205 | 390 |
| Other counties [b] and small mines | 714,364 | 123,525 | 6,517 | ........ | 844,406 | 979,186 | 1.16 | 214 | 1,046 |
| Total | 29,738,788 | 1,859,906 | 542,425 | 1,300 | 32,142,419 | 35,324,746 | 1.10 | 199 | 46,833 |

[a] Morgan, Noble, and Portage.
[b] Monroe, Morgan, Noble, Portage, Scioto, and Trumbull.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Ohio, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Athens | 3,424,958 | 3,324,115 | 3,601,448 | 4,003,074 | 4,562,694 | + 559,620 |
| Belmont | 2,725,849 | 3,172,350 | 3,957,980 | 4,266,865 | 6,208,188 | + 1,941,323 |
| Carroll | 254,440 | 235,010 | 227,517 | 195,713 | 367,062 | + 171,349 |
| Columbiana | 907,325 | 802,667 | 811,125 | 607,417 | 709,515 | + 102,098 |
| Coshocton | 454,008 | 340,344 | 381,752 | 367,600 | 403,015 | + 35,415 |
| Gallia | 48,948 | 29,642 | 25,845 | 47,495 | 35,195 | − 12,300 |
| Guernsey | 2,776,829 | 3,124,702 | 2,919,704 | 3,273,838 | 3,970,921 | + 697,083 |
| Harrison | 259,047 | 264,519 | 358,478 | 280,232 | 499,300 | + 219,068 |
| Hocking | 2,506,410 | 2,458,402 | 1,931,017 | 1,793,112 | 1,648,581 | − 144,531 |
| Holmes | 41,338 | 30,528 | 20,975 | 39,465 | 22,165 | − 17,300 |
| Jackson | 2,411,145 | 1,936,451 | 1,888,932 | 1,369,800 | 1,284,877 | − 84,923 |
| Jefferson | 2,479,211 | 2,416,122 | 3,269,376 | 4,515,420 | 4,528,006 | + 12,586 |
| Lawrence | 228,251 | 183,604 | 179,546 | 177,145 | 243,027 | + 65,882 |
| Mahoning | 123,206 | 87,515 | 116,138 | 117,989 | 94,335 | − 23,654 |
| Medina | 132,823 | 98,433 | 56,646 | 73,119 | 46,071 | − 27,048 |
| Meigs | 316,888 | 185,396 | 349,191 | 429,435 | 330,503 | − 98,932 |
| Morgan | 93,675 | 83,800 | 173,766 | 223,625 | 321,793 | + 98,168 |
| Muskingum | 281,649 | 257,498 | 198,304 | 282,348 | 414,121 | + 131,773 |
| Perry | 2,731,282 | 2,437,824 | 2,299,419 | 2,557,588 | 2,901,147 | + 343,559 |
| Portage | 109,794 | 101,050 | 84,178 | 96,467 | 95,462 | − 1,005 |
| Stark | 910,865 | 768,113 | 598,061 | 579,640 | 687,866 | + 108,226 |
| Summit | 42,118 | 89,985 | 113,443 | 104,216 | 104,236 | + 20 |
| Trumbull | 10,652 | 12,900 | 1,875 | ............ | 1,000 | + 1,000 |
| Tuscarawas | 1,279,636 | 1,552,065 | 1,364,043 | 1,413,751 | 1,797,399 | + 383,648 |
| Vinton | 192,069 | 206,622 | 226,417 | 210,984 | 254,529 | + 43,545 |
| Washington | 3,600 | 9,550 | 1,424 | ............ | ............ | ............ |
| Wayne | 69,870 | 81,369 | 190,537 | 215,031 | 185,260 | − 29,771 |
| Noble<br>Scioto | [a] 8,681 | 90,963 | 178,050 | 401,316 | 314,761 | − 86,555 |
| Small mines | 13,536 | 18,681 | 27,763 | 88,955 | [b] 111,390 | + 22,435 |
| Total | 24,838,103 | 24,400,220 | 25,552,950 | 27,731,640 | 32,142,419 | + 4,410,779 |
| Total value | $31,932,327 | $26,579,738 | $26,486,740 | $30,346,580 | $35,324,746 | + $4,978,166 |

[a] No production in Noble County.

[b] Includes production of Monroe County.

The areas in Ohio now or formerly underlain by coal are estimated at 12,660 square miles. Much of the coal, however, has been exhausted, and the workable areas at the present time are much below this figure. The coal-bearing formations contain at least 16 different coal beds within this State. Of these, 6 are important and have been developed on a large scale, while the other 10 have been developed principally by small mines, a large part of the output of which is sold for local consumption. The important productive beds are the Block (Sharon coal), or No. 1; Wellston, or No. 2; Lower Kittanning, No. 5; Middle Kittanning, No. 6; Upper Freeport, No. 7, and Pittsburg, No. 8.

Some of the coals of Ohio are celebrated for certain uses. That of the Hocking Valley region, which is contained in Perry, Athens, and Hocking counties, is a free, open-burning coal, highly regarded as a steam and domestic coal, but more popular as a furnace fuel, for which purpose it is used raw. The Hocking Valley coal belongs to the Middle Kittanning, or No. 6 bed. The No. 7, or Upper Freeport, which is mined in Muskingum, Gallia, Lawrence, and Guernsey counties, and in portions of Perry County, is a high-grade steam fuel and would make, except for its high contents of sulphur, an excellent coke. On account of the high sulphur, however, no coke is made from this coal in the State. The Pittsburg bed, or No. 8 of the State series, lies in Jefferson, Harrison, Belmont, Guernsey, Athens, and Meigs counties. It is the base of the upper coal measures in the State, and is the most important of all the beds within these measures.

Coal No. 1, or the block coal, is mined in the northeastern counties of the State, especially in Summit, Stark, Trumbull, and Mahoning counties, and a small quantity in Portage County. This coal is very pure and is used principally in making pig iron, for which it is used in its raw state in the blast furnace. It was this coal which first supplanted charcoal in the blast furnaces of the State. It is dry, free burning, and does not coke. The Massillon coal, highly prized for domestic purposes in Cleveland and other cities on the Lakes, is obtained from this bed. The Wellston bed, which lies above the block, is the most important producing bed in the southern portion of the State. The mines in Jackson County, at Jackson and Wellston, are worked on this bed.

One of the early reports published by Ohio states that in 1838 there were 119,952 short tons produced from the coal mines of the State. It is probable that some coal was mined in Ohio prior to that date, but we have no record of such production. The United States census of 1840 credited Ohio with an output of 140,536 tons. The census of 1850 did not consider the coal-mining industry, and the next report we have of coal production in the State was that of the census of 1860, which recorded an output of 1,265,600 short tons. The production since 1838 is given in the table on a preceding page, showing the production of coal in the United States from the earliest times to the close of 1907.

Mr. Marius R. Campbell, of the U. S. Geological Survey, in his report on the coal fields of the United States, estimates that there were 86,028,000,000 short tons in the original coal supply of Ohio. The total production of the State to the close of 1907 was 492,769,358 tons, of which the production in that year amounted to a little less than 7 per cent. The total output to the close of 1907 represents an exhaustion of 739,000,000 tons, or somewhat less than 0.9 of 1 per cent of the estimated original supply.

## OKLAHOMA.

Total production in 1907, 3,642,658 short tons; spot value, $7,433,914.

Since the report for 1906 was published the area included within the Territory of Oklahoma and the Indian Territory has been organized and admitted into the Union as the State of Oklahoma. As, however, the entire coal-producing district is included in what was Indian Territory, the production of Oklahoma is coordinate with what was the production of Indian Territory.

The new State began its history of coal production with a noteworthy increase over that of Indian Territory in 1906, when the output amounted to 2,860,200 short tons, valued at $5,482,366. Compared with this, the production of 1907 showed an increase of 782,458 tons, or 27.36 per cent in quantity, and of $1,951,548, or 35.6 per cent in value. There were only three States whose percentage of increase in 1907 over 1906 exceeded that of Oklahoma. These were Michigan, whose production increased 51 per cent; Arkansas, which had an increase of 43.3 per cent, and New Mexico, with an increase of 33.8 per cent. As was the case in Arkansas, the coal-mining industry of Oklahoma in 1907 was one of the most prosperous in the history of that coal-producing region, for the increased production in 1907 was accompanied by an advance in the average price per ton—from $1.92 in 1906 to $2.04 in 1907. The conditions affecting the industry in Arkansas and Oklahoma have been referred to in the discussion of the production of Arkansas and need not be repeated here, the falling-off in the production of petroleum in Texas, and the constant advance in the price of oil having naturally created a better demand for Arkansas and Oklahoma coals in the territory tributary to the coal fields of those States. Unless the conditions change in this respect, the production of this region may be expected to increase, provided, of course, that normal industrial conditions obtain. During the first part of 1907 the industry suffered materially from insufficient car supply, and this was by no means exceptional. The influences of the money disturbance were felt principally here, as in some of the other States, in the unwillingness of men to accept payment for wages in anything but actual cash, but this does not seem to have materially affected the production. One of the evils existing in the State which does affect the quality of the product is the practice of shooting coal from the solid, which produces an excess of slack or fine coal, for which there is no profitable market.

The number of men employed in the coal mines of Oklahoma in 1907 was 8,398, who worked an average of 216 days, compared with 8,251 men for an average of 166 days in 1906, during which year there were 7,372 men idle during a period of suspension, these men being idle an average of 72 days. The total time lost in 1906 was equivalent to 40 per cent of the total time made. In 1907 there were 669 men idle for an average of 26 days, and the total time lost was equivalent to a little less than 1 per cent of the time worked. The average production per man in 1907 was 434 tons, as against 346.6 tons in 1906, and 379.2 tons in 1905. The average daily production per man was 2.01 tons in 1907, against 2.09 tons in 1906, and 2.02 tons in 1905. Practically all of the mines of the State are operated on the basis of the 8-hour day.

The decline in the use of mining machinery in Oklahoma, referred to in the reports for 1905 and 1906, continued in 1907, and this was probably due to the prevalent practice of "shooting from the solid." In 1902 there was a total machine-mined product in Indian Territory of 119,195 short tons. In 1905 the machine-mined tonnage had fallen off to 40,203; in 1906, to 33,357, while in 1907 the machine-mined production amounted to only 24,331 tons, or 0.67 of 1 per cent of the total output. In 1902, 4.23 per cent of the total production was mined by machines.

The fatality record for Oklahoma, as reported by Mr. William Cameron, formerly the Territorial mine inspector, for 1907, shows that there were 89 accidents during the year, a decrease of 3 from 1906; 33 men were killed and 56 injured in 1907, against 44 men killed and 48 injured in 1906. Of the 33 fatalities, 6 were due to gas and dust explosions; 11 to powder explosions and misplaced shots, and 11 to falls of roof of coal, 5 being attributed to other causes. The death rate per 1,000 employees was 3.9, and there were 110,384 tons of coal mined for each life lost.

The statistics relating to the washing of coal, as reported to the Geological Survey, show that there were 92,710 tons of coal washed in 1907, yielding 80,871 tons of clean coal, and 11,839 tons of refuse.

The statistics of production of coal in Oklahoma (Indian Territory) during the last five years, with the distribution of the product for consumption, are shown in the following table:

*Distribution of the coal product of Oklahoma (Indian Territory), 1903–1907, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| 1903 | 3,329,610 | 32,610 | 78,995 | 76,173 | 3,517,388 | $6,386,463 | $1.82 | 247 | 7,704 |
| 1904 | 2,823,484 | 35,512 | 122,266 | 65,277 | 3,046,539 | 5,532,066 | 1.82 | 199 | 8,487 |
| 1905 | 2,707,377 | 38,898 | 106,547 | 71,605 | 2,924,427 | 5,145,358 | 1.76 | 188 | 7,712 |
| 1906 | 2,629,731 | 38,535 | 122,299 | 69,635 | 2,860,200 | 5,482,366 | 1.92 | 166 | 8,251 |
| 1907 | 3,381,420 | 58,882 | 161,957 | 40,399 | 3,642,658 | 7,433,914 | 2.04 | 216 | 8,398 |

The coal-bearing rocks of Oklahoma form a part of the western interior coal field. They extend from what was Indian Territory into Kansas on the north and into Arkansas on the east. Within the State this field has an approximate area of 20,000 square miles, underlying the western half of the area formerly known as the Cherokee Nation, the whole of what was the Creek Nation, the northern third of what was the Choctaw Nation, and a small portion of the former Chickasaw Nation. The total area underlain by workable coal is estimated to be about 10,000 square miles.

At present the entire production is from what were formerly known as the Cherokee, Creek, and Choctaw nations, the last-named contributing by far the largest portion.

The coal-bearing rocks of Oklahoma belong to the Pennsylvanian series of the Carboniferous. The coals, of which there are 10 or more beds, vary from a medium low on the one hand to high-grade bituminous, approaching semianthracite, on the other. Some of the high-grade bituminous varieties possess coking qualities. Several hundred ovens are in operation in the eastern and western parts of what was the Choctaw field. Much of the slack that is produced is washed and turned into coke.

The greater portion of the developments in Oklahoma has been in the former Choctaw Nation, accessible to the Missouri, Kansas and Texas, the St. Louis and San Francisco, and the Kansas City Southern railroads, which cross Oklahoma north and south, and to the Choctaw, Oklahoma and Gulf and the Midland Valley roads, which cross the State from east to west.

The Tenth United States Census (1880) contains the first published record of the production of coal in Oklahoma (Indian Territory), although as a small quantity of coal was mined in Arkansas as early as 1840 it is probable that some was produced in the former Territory earlier than 1880. The maximum production prior to 1907 was obtained in 1903, when a total of 3,517,388 tons was mined. Compared with this, the production of 1907 shows an increase of 125,270 tons.

## OREGON.

Total production in 1907, 70,981 short tons; spot value, $166,304.

The only productive coal field in Oregon is situated in the southwestern part of the State, in Coos County, and is known as the Coos

Bay field, from the fact that it entirely surrounds that body of water. It occupies a total area of about 230 square miles, its length north and south being about 30 miles and its maximum breadth at the middle about 11 miles, tapering regularly toward both ends. Other coal fields have been prospected in different parts of the State. Among these are the Upper Nehalem field, in Columbia County; the Lower Nehalem, in Clatsop and Tillamook counties; the Yaquina field, in Lincoln County; the Eckley and Shasta Costa fields, in Curry County; the Eden field, in Coos County, and the Rogue River Valley field, in Jackson County. All of these fields lie west of the Cascade Range, but none has been developed to the point of production. Another field has been located in the basin of the John Day River, east of the Cascade Range, but little is known concerning it. All of the fields west of the range, with the exception of the Coos Bay, are of limited area, the largest, outside of the Coos Bay, being the Upper Nehalem, which has an area of less than 20 square miles. All of the coal of these fields is lignitic in character. Transportation is confined exclusively to Coos Bay and the Pacific Ocean, and San Francisco is the principal market. The Coos Bay field is divided by its structure into 6 portions—4 basins and 2 arches. The basins are known as the Newport, the Beaver Slough, the Coquille, and the South Slough, and are separated by the Westport and Pulaski arches.

The coal production in Oregon during the last three years has been adversely affected by the great increase in the production of petroleum in California, and its use for fuel purposes. As practically all of the product from Coos Bay has been shipped by water to San Francisco, the substitution of oil for coal in most of the manufacturing industries has cut off a considerable portion of the market for this coal. The effect upon Oregon's production is shown in a decrease from 109,641 tons in 1905 to 79,731 in 1906, and to 70,901 tons in 1907. The decrease in value of the 1907 product was even more pronounced, for while the production showed a decrease of 8,750 tons, or 10.97 per cent, the value declined $46,034, or 21.68 per cent. The average price per ton declined from $2.66 in 1906 to $2.34 in 1907.

The statistics of coal production in Oregon, with the distribution of the product for consumption, for the last five years are shown in the following table:

*Distribution of the coal product in Oregon, 1903–1907, in short tons.*

| Year. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days worked. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| 1903 | 67,192 | 9,848 | 14,104 | 91,144 | $221,031 | $2.43 | 258 | 235 |
| 1904 | 79,293 | 13,968 | 18,279 | 111,540 | 243,588 | 2.18 | 284 | 334 |
| 1905 | 84,258 | 7,883 | 17,500 | 109,641 | 282,495 | 2.58 | 242 | 316 |
| 1906 | 55,232 | 7,398 | 17,101 | 79,731 | 212,338 | 2.66 | 209 | 224 |
| 1907 | 39,095 | 14,840 | 17,046 | 70,981 | 166,304 | 2.34 | 231 | 184 |

Coal was first noted in the Coos Bay region about 50 years ago, Prof. N. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention. It is known that some mining was done there in 1855 and 1872, and in 1876 two mines, the Eastport and the Newport, were in active operation. The Newport, however, is the only one to survive. The Beaver Hill mine, opened in 1895, was at first rather an uncertain factor, but is now an important producer. The census of 1880 reports the total production of the State at 43,205 tons, this being the earliest record of such production. The total production has exceeded 100,000 tons in 4 years only—1896, 1897, 1904, and 1905—the maximum being obtained in 1904, when it reached 111,540 tons.

## PENNSYLVANIA.

Total production in 1907, 235,747,489 short tons; spot value, $319,248,082.

*Anthracite.*—Total production in 1907, 76,432,421 long tons (equivalent to 85,604,312 short tons); spot value, $163,584,056.

*Bituminous.*—Total production in 1907, 150,143,177 short tons; spot value, $155,664,026.

Both in anthracite and bituminous coal production Pennsylvania in 1907 exceeded any previous record in the history of the State. Compared with 1906, when the aggregate production amounted to 200,575,617 short tons, valued at $262,208,345, the output in 1907 exhibits an increase of 35,171,872 short tons, or 17.5 per cent in quantity, and of $57,039,737, or 21.8 per cent in value. The increase in the production of anthracite coal was 12,787,412 long tons (equivalent to 14,321,901 short tons), or 20.1 per cent in quantity, and $31,666,362, or 24 per cent in value.

In the production of bituminous coal the increase was 20,849,971 short tons, or 16.13 per cent in quantity, and $25,373,375, or 19.47 per cent in value. The marked increase in both anthracite and bituminous coal in 1907 was due to the fact that the production of both was somewhat restricted in 1906 by the suspension of mining operations on April 1 of that year, pending the adjustment of the wage scale. In spite of this loss of time the production of bituminous coal in 1906 showed a gain of nearly 11,000,000 tons over 1905, but the production of anthracite decreased 5,694,142 long tons, or 6,377,439 short tons. The abnormally large increase in the production of anthracite in 1907 makes up for the depletion of stocks caused by the suspension, and represents a little more than a normal increase over the production of 1905.

The total number of men employed in the coal mines of Pennsylvania in 1907 was 330,529, of which 167,234 were employed in the anthracite mines and 163,295 in the bituminous mines. The anthracite workers averaged 220 days and the bituminous men 255 days. The average production per man for the year in the anthracite mines was 512 short tons and in the bituminous mines 919.5 short tons. The daily average per man was 2.33 tons of anthracite and 3.61 tons of bituminous. In 1906 the average production per man per day was 2.25 tons of anthracite and 3.68 tons of bituminous.

Mr. James E. Roderick, chief of the department of mines of Pennsylvania, reports that in 1907 there were 708 men killed and 1,369 injured in the anthracite mines; and 806 men killed and 1,207 injured in the bituminous mines. In 1906 there were 557 men killed and

1,212 injured in the anthracite mines, and 477 killed and 1,160 injured in the bituminous mines. Of the total number of men killed in the working of the anthracite mines in 1907, 601 were killed inside the mines and 107 outside, while 766 men were killed inside and 40 outside the bituminous mines. The death rate per thousand of employees in the anthracite mines was 4.23 in 1907 against 3.43 in 1906, while the death rate per thousand in the bituminous mines was 4.94 in 1907 against 3.14 in 1906. In the production of anthracite 120,910 short tons were mined for each life lost in 1907 against 127,976 tons in 1906, while in the bituminous mines 186,281 short tons were mined for each life lost in 1907, against 271,055 tons in 1906. In the anthracite region 44 of the deaths were due, in 1907, to dust explosions, 87 to powder explosions and windy shots, 279 to falls of roof or coal. In the bituminous mines 276 men were killed by gas and dust explosions, 15 by powder explosions and windy shots, and 307 by falls of roof or coal.

The rapid growth of bituminous coal production compared with that of anthracite during recent years has been marked and forms one of the most interesting features connected with the statistics of coal mining. Reference has been made to this in previous reports of this series, and the following table has been prepared showing the average production of Pennsylvania anthracite and of bituminous coal throughout the United States, by 5-year periods, from 1876 to 1905, and for 1906 and 1907, with the percentage each bears to the total. It will be seen from this table that the average production of anthracite during the 5 years from 1901 to 1905 was 2.59 times the average yearly production from 1876 to 1880, and that the production of anthracite in 1907 was 3.32 times the average annual production from 1876 to 1880. In the bituminous production the tonnage from 1901 to 1905 was 7.5 times that of the output from 1876 to 1880, while the production in 1907 was 10.83 times that of the average for the 5 years from 1876 to 1880.

From 1876 to 1880 the average production of bituminous coal was 1.41 times that of anthracite, while from 1901 to 1905 the production of bituminous coal was 4.08 times that of hard coal. From 1866 to 1870 the production of Pennsylvania anthracite was a little more than half the production of the United States. The reason for this comparatively large gain in the production of bituminous coal lies in the fact that anthracite has been for a number of years becoming more and more of a luxury, and this condition will continue to obtain until the areas are finally exhausted. The comparatively restricted area in which anthracite is produced and the increasing cost of production as deeper and thinner beds have to be worked have resulted, naturally, in the gradual advance in price and also in the gradual elimination of anthracite as a fuel for manufacturing purposes. It is now almost entirely restricted to domestic consumption in the Eastern States. Large amounts of the smaller sizes of anthracite which were formerly wasted are now used for steaming purposes, sometimes mixed with bituminous coal and sometimes alone, but for these purposes the smaller sizes are used chiefly for heating and running elevators in office buildings, hotels, and apartment houses, rather than for manufacturing purposes. Even for domestic purposes coke and gas, the products of bituminous coal, are competing more and more with anthracite in the markets of the larger cities and towns. Under these conditions the statistical situation is not difficult to understand.

The average production of anthracite and bituminous coal, by 5-year periods from 1876 to 1905, and for 1906 and 1907, is shown in the following table:

*Production of anthracite and bituminous coal since 1876, by 5-year averages, in short tons.*

| Period. | Anthracite. | | Bituminous. | |
|---|---|---|---|---|
| | Quantity. | Per cent of total. | Quantity. | Per cent of total. |
| 1876–1880 | 25,800,169 | 41.44 | 36,460,776 | 58.56 |
| 1881–1885 | 36,198,188 | 33.74 | 71,092,930 | 66.26 |
| 1886–1890 | 43,951,763 | 31.76 | 94,446,451 | 68.24 |
| 1891–1895 | 53,405,187 | 29.87 | 125,416,327 | 70.13 |
| 1896–1900 | 55,625,265 | 24.49 | 171,498,143 | 75.51 |
| 1901–1905 | 66,853,778 | 19.70 | 272,503,363 | 80.30 |
| 1906 | 71,282,411 | 17.21 | 342,874,867 | 82.79 |
| 1907 | 85,604,312 | 17.82 | 394,759,112 | 82.18 |

Until 1902 Pennsylvania had enjoyed the distinction of producing more than half the coal output of the United States. From 1889 to 1901, however, the percentage of anthracite production had shown a gradually decreasing tendency and when the anthracite strike of 1902 caused a decided shrinkage in the production of Pennsylvania anthracite, the percentage of the State was reduced to 46. In 1903, notwithstanding the increased production of anthracite and bituminous coal in Pennsylvania in that year, the State's proportion of the total production of the United States was still slightly less than half. In 1904 Pennsylvania produced 49 per cent of the total, and in 1905, with an increase of nearly 25,000,000 tons over the preceding year, the State's proportion of the total production was 49.9 per cent. In 1906 Pennsylvania's percentage again fell off to 48.4 per cent, but with the largely increased production of both anthracite and bituminous coal in 1907, the State's percentage again rose to 49.1. It is doubtful if Pennsylvania will in future contribute more than half of the country's total. In 1880 Pennsylvania produced 66 per cent of the entire output of the United States, and during the last 25 years has produced about 53 per cent of the total.

Pennsylvania alone produces more coal than any other country in the world, with the exception of Great Britain. Pennsylvania's production of coal exceeds, in fact, the combined production of all the countries of the world outside of Great Britain and Germany. Pennsylvania's output in 1907 was 5.36 times that of Austria-Hungary, 5.79 times the production of France, and 8.98 times the production of Belgium, these being, respectively, fourth, fifth, and sixth among the coal-producing countries of the world.

The following table shows the total production of the United States since 1880, with the percentages of the tonnage produced by Pennsylvania in each year:

*Production of Pennsylvania coal compared with total United States, 1880–1907, in short tons.*

| Year. | Total United States. | Pennsylvania. | Percentage of Pennsylvania to total. | Year. | Total United States. | Pennsylvania. | Percentage of Pennsylvania to total. |
|---|---|---|---|---|---|---|---|
| 1880 | 71,481,570 | 47,074,975 | 66 | 1894 | 170,741,526 | 91,833,584 | 54 |
| 1881 | 85,881,030 | 54,320,018 | 63 | 1895 | 193,117,530 | 108,216,565 | 56 |
| 1882 | 103,285,789 | 57,254,507 | 55 | 1896 | 191,986,357 | 103,903,534 | 54 |
| 1883 | 115,212,125 | 62,488,190 | 54 | 1897 | 200,223,665 | 107,029,654 | 53 |
| 1884 | 119,735,051 | 62,404,488 | 52 | 1898 | 219,976,267 | 118,547,777 | 54 |
| 1885 | 110,957,522 | 62,137,271 | 56 | 1899 | 253,741,192 | 134,568,180 | 53 |
| 1886 | 112,743,403 | 62,857,210 | 56 | 1900 | 269,684,027 | 137,210,241 | 51 |
| 1887 | 129,975,557 | 70,372,857 | 54 | 1901 | 293,299,816 | 149,777,613 | 51 |
| 1888 | 148,659,402 | 77,719,624 | 52 | 1902 | 301,590,439 | 139,947,962 | 46 |
| 1889 | 141,229,514 | 81,719,059 | 58 | 1903 | 357,356,416 | 177,724,246 | 49.7 |
| 1890 | 157,770,963 | 88,770,814 | 56 | 1904 | 351,816,398 | 171,094,996 | 49 |
| 1891 | 168,566,668 | 93,453,921 | 55 | 1905 | 392,722,635 | 196,073,487 | 49.9 |
| 1892 | 179,329,071 | 99,167,080 | 55 | 1906 | 414,157,278 | 200,575,617 | 48.4 |
| 1893 | 182,352,774 | 98,038,267 | 54 | 1907 | 480,363,424 | 235,747,489 | 49.1 |

## PENNSYLVANIA ANTHRACITE.

By William W. Ruley.

Considered as to tonnage of shipments, the year 1907 was the most remarkable in the history of the anthracite trade, the shipments amounting to 67,109,393 long tons, 5,699,192 tons more than in 1905, which had been the record year; compared with 1906 the increase was 11,410,798 tons.

The principal reason for the large falling off in the shipments for 1906 as compared with 1905 was the suspension of mining from April 1 to May 16, 1906, which resulted in an approximate loss of 7,500,000 tons. This reduction was undoubtedly most effective in stimulating the demand for the remainder of the year 1906, and had the additional effect of cleaning up stocks and leaving the market in a condition to absorb the great tonnage of 1907. The average of the shipments for the three years from 1905 to 1907, inclusive, is about the same as the tonnage of 1905, and the deficit in the shipments of 1906 is about made up by the increase in 1907—in fact, this average only varies a few thousand tons from the 1905 shipments, as is shown by the following figures:

*Shipments of Pennsylvania anthracite, 1905–1907, in long tons.*

| | |
|---|---|
| 1905 | 61,410,201 |
| 1906 | 55,698,595 |
| 1907 | 67,109,393 |
| Total | 184,218,189 |
| Average | 61,406,063 |

The difference between the average and the shipments for 1905 is only a trifle over 4,000 tons.

It might be said that this average represents the yearly demand under normal business conditions, but such a conclusion could be applied only to a very short period.

There has been a steady though irregular increase in the shipments of anthracite coal. Many estimates and predictions have been made as to the point when the maximum production would be reached, and the writer has referred to these matters at some length in previous reports, but apart from the yearly variations and the general increase in production there is abundant evidence that the entire anthracite situation has undergone a complete change within the last ten years in so far as supply and demand are concerned. Ten years ago the producing capacity of the anthracite territory was in excess of the demand; at the present time under normal conditions the market's requirements are quite equal to the supply. It would seem, therefore, that even with the limited territory in which anthracite is used to any considerable extent, and taking into account also various other competing fuels, the natural increase in the population of this territory will soon increase the demand to an extent for which the supply will not be adequate. When the limited anthracite-producing territory is considered, the question as to whether there is a possibility of any considerable increase in its development, even for a comparatively short time, becomes pertinent; the ultimate result is certain—the demand must be in excess of the supply.

The monthly shipments of anthracite coal for 1905, 1906, and 1907 are shown below:

*Monthly shipments of anthracite coal, 1905–1907, in long tons.*

| Month. | 1905. | 1906. | 1907. |
|---|---|---|---|
| January | 4,408,578 | 5,458,084 | 5,249,946 |
| February | 3,922,601 | 4,712,099 | 4,563,720 |
| March | 5,258,567 | 5,797,167 | 5,235,814 |
| April | 5,278,041 | 488,203 | 5,916,583 |
| May | 6,005,158 | 3,254,230 | 5,994,272 |
| June | 5,844,052 | 5,676,018 | 5,976,906 |
| July | 4,546,743 | 4,981,448 | 5,669,024 |
| August | 5,041,838 | 5,400,511 | 5,795,347 |
| September | 5,082,232 | 4,527,886 | 5,512,717 |
| October | 5,205,694 | 5,384,768 | 6,108,065 |
| November | 5,421,584 | 5,182,153 | 5,743,522 |
| December | 5,395,113 | 4,836,028 | 5,343,477 |
| Total | 61,410,201 | 55,698,595 | 67,109,393 |

In connection with the increase in the general production of anthracite it is interesting to note the proportion of increase in the domestic sizes and that in the small or steam sizes. In 1890 the proportion was 76.9 per cent of sizes above pea, and 23.1 per cent of pea coal and smaller sizes; in 1900 it was 64.7 and 35.3 per cent, respectively, and in 1907 to 58.6 and 41.4, respectively. This shows a most astonishing change in the percentages of the sizes, but it should be borne in mind that a considerable part of this increase in small-size coal is due to the washery product; in 1890 this amounted to only 41,600 tons, or 0.11 per cent of total shipments; in 1907 it amounted to 4,301,082 tons, or 6.41 per cent. If the washery product be deducted from the total shipments, the results are as follows:

*Shipments of anthracite, excluding washery product, by sizes, 1890 and 1907, in long tons.*

| Year. | Sizes above pea. | | Pea and smaller. | | Total shipments. |
|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | |
| 1890 | 28,154,678 | 76.98 | 8,419,181 | 23.02 | 36,573,859 |
| 1907 | 39,301,444 | 62.57 | 23,506,867 | 37.43 | 62,808,311 |

This table shows that with the washery product eliminated from the total shipments the percentage of small sizes is very much reduced in 1907, while it is not materially affected in 1890. However, leaving out of consideration the great increase in washery coal, it is plainly evident that the proportion of small sizes in fresh-mined coal has been steadily increasing. As to the causes for this increase, the reader is referred to the reports for 1905 and 1906, in which this subject was discussed at some length.

To illustrate the change in the proportion of domestic and steam sizes since 1890, the following table is appended:

*Shipments of anthracite, according to sizes, 1890–1907, in long tons.*

| Year. | Sizes above pea. | | Pea and smaller. | | Total shipments. |
|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | |
| 1890 | 28,154,678 | 76.9 | 8,460,781 | 23.1 | 36,615,459 |
| 1891 | 30,604,566 | 75.7 | 9,843,770 | 24.3 | 40,448,336 |
| 1892 | 31,868,278 | 76.0 | 10,025,042 | 24.0 | 41,893,320 |
| 1893 | 32,294,233 | 74.9 | 10,795,304 | 25.1 | 43,089,537 |
| 1894 | 30,482,203 | 73.7 | 10,908,997 | 26.3 | 41,391,200 |
| 1895 | 32,469,367 | 69.9 | 14,042,110 | 30.1 | 46,511,477 |
| 1896 | 30,354,797 | 70.3 | 12,822,688 | 29.7 | 43,177,485 |
| 1897 | 28,510,370 | 68.5 | 13,127,494 | 31.5 | 41,637,864 |
| 1898 | 28,198,532 | 67.3 | 13,701,219 | 32.7 | 41,899,751 |
| 1899 | 31.506,700 | 66.1 | 16,158.504 | 33.9 | 47,665,204 |
| 1900 | 29,162,459 | 64.7 | 15,945,025 | 35.3 | 45,107,484 |
| 1901 | 34,412,974 | 64.2 | 19,155,627 | 35.8 | 53,568,601 |
| 1902 | 19,025,632 | 61.0 | 12,175,258 | 39.0 | 31,200,890 |
| 1903 | 37,738,510 | 63.6 | 21,624,321 | 36.4 | 59,362,831 |
| 1904 | 35,636,661 | 62.0 | 21,855,861 | 38.0 | 57,492,522 |
| 1905 | 37,425,217 | 60.9 | 23,984,984 | 39.1 | 61,410,201 |
| 1906 | 32,894,124 | 59.1 | 22,804,471 | 40.9 | 55,698.505 |
| 1907 | 39,332,855 | 58.6 | 27,776,538 | 41.4 | 67,109,393 |

It should be noted in connection with the division of sizes that pea coal, which was for years a steam coal, is now used very extensively for domestic purposes; and while it is impossible to tell what proportion is so used, the fact that it is no longer an exclusively steam size must be taken into consideration in drawing deductions from the figures presented.

To present statistically the comments made on size division, washery production, etc., the following table, showing washery production since 1890, is given:

*Shipments of anthracite from washeries and total shipments, 1890-1907, in long tons.*

| Year. | Shipments from washeries. | Total shipments. | Percentage of washery output to total shipments. |
|---|---|---|---|
| 1890 | 41,600 | 36,615,459 | 0.11 |
| 1891 | 85,702 | 40,448,336 | .21 |
| 1892 | 90,495 | 41,893,320 | .22 |
| 1893 | 245,175 | 43,089,537 | .57 |
| 1894 | 634,116 | 41,391,200 | 1.53 |
| 1895 | 1,080,800 | 46,511,477 | 2.52 |
| 1896 | 895,042 | 43,177,485 | 2.07 |
| 1897 | 993,603 | 41,637,864 | 2.39 |
| 1898 | 1,099,019 | 41,899,751 | 2.62 |
| 1899 | 1,368,275 | 47,665,204 | 2.87 |
| 1900 | 2,059,349 | 45,107,484 | 4.57 |
| 1901 | 2,567,335 | 53,568,601 | 4.79 |
| 1902 | 1,959,466 | 31,200,890 | 6.28 |
| 1903 | 3,563,269 | 59,362,831 | 6.00 |
| 1904 | 2,800,466 | 57,492,522 | 4.87 |
| 1905 | 2,644,045 | 61,410,201 | 4.31 |
| 1906 | 3,846,501 | 55,698,595 | 6.91 |
| 1907 | 4,301,082 | 67,109,393 | 6.41 |

In the preceding discussion of shipments the coal from the mines of Sullivan County has not been considered, the reason therefor being given in a paragraph at the end of this report. It should also be noted that the foregoing comments have dealt only with shipments and have taken no account of coal sold locally at the mines or used for steam and heat. In the following paragraphs and tables Sullivan County is taken into consideration, and also the local trade and mine, coal.

The production for the year 1907 amounted to 76,432,421 tons, being an increase of 12,787,411 tons over the production for 1906. Of this production, 67,458,784 tons (including 349,391 tons from Sullivan County) were shipped to market, 1,516,831 tons were sold to local trade, and 7,456,806 tons were used at mines for steam and heat.

The following table gives a comparison of these figures for the last five years:

*Statistics of anthracite production, 1903-1907.*

| Year. | Quantity (long tons). | Value. | Average price per ton. | Average number of men employed. | Average number of days worked. |
|---|---|---|---|---|---|
| 1903 | 66,613,454 | $152,036,448 | $2.50 | 150,483 | 206 |
| 1904 | 65,318,490 | 138,974,020 | 2.35 | 155,861 | 200 |
| 1905 | 69,339,152 | 141,879,000 | 2.25 | 165,406 | 218 |
| 1906 | 63,645,010 | 131,917,694 | 2.30 | 162,355 | 195 |
| 1907 | 76,432,421 | 163,584,056 | 2.35 | 167,234 | 220 |

In the valuation of product no account has heretofore been taken of coal used for steam and heat; but as every size and even dust is now a marketable product, it has been thought advisable to give this coal an arbitrary value of 20 cents per ton, which has been included in the value of the total product for 1907, but which does not enter into the values for previous years. The tables following show the production, shipments, local trade, and coal used at mines, by counties, for the years 1906 and 1907:

*Anthracite production in 1906 and 1907, by counties, in long tons.*

| County. | Shipments. | Sold to local trade and employees. | Used at mines for steam and heat. | Total. |
|---|---|---|---|---|
| 1906. | | | | |
| Susquehanna | 456,967 | 8,542 | 36,369 | 501,878 |
| Lackawanna | 15,015,345 | 370,577 | 1,141,797 | 16,527,719 |
| Luzerne | 20,636,738 | 550,661 | 2,259,890 | 23,447,289 |
| Carbon | 1,744,229 | 64,164 | 214,130 | 2,022,523 |
| Schuylkill | 12,512,308 | 229,125 | 1,722,600 | 14,464,033 |
| Columbia | 736,816 | 14,548 | 107,939 | 859,303 |
| Sullivan | 287,830 | 4,548 | 27,825 | 320,203 |
| Northumberland | 4,143,877 | 106,361 | 595,818 | 4,846,056 |
| Dauphin | 452,315 | 20,568 | 183,123 | 656,006 |
| Total | 55,386,425 | 1,369,094 | 6,289,491 | 63,045,010 |
| 1907. | | | | |
| Susquehanna | 520,955 | 9,623 | 44,503 | 575,081 |
| Lackawanna | 17,955,465 | 382,730 | 1,570,532 | 19,908,727 |
| Luzerne | 24,081,491 | 666,902 | 2,581,483 | 27,329,876 |
| Carbon | 2,150,801 | 50,035 | 257,381 | 2,458,217 |
| Schuylkill | 15,625,710 | 256,264 | 2,081,171 | 17,963,145 |
| Columbia | 931,767 | 14,136 | 115,051 | 1,060,954 |
| Sullivan | 349,391 | 5,152 | 32,155 | 386,698 |
| Northumberland | 5,302,642 | 109,534 | 596,493 | 6,008,669 |
| Dauphin | 540,562 | 22,455 | 178,037 | 741,054 |
| Total | 67,458,784 | 1,516,831 | 7,456,806 | 76,432,421 |

The following table gives the yearly shipments of anthracite from the earliest date to the close of 1907, divided according to the three trade regions. These shipments include only coal loaded on cars for line or tide-water points, and do not include any coal sold locally or used at and about the mines, nor the shipments from the Sullivan County mines.

*Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1907, in long tons.*

| Year. | Schuylkill region. | | Lehigh region. | | Wyoming region. | | Total. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. |
| 1820 | | | 365 | | | | 365 |
| 1821 | | | 1,073 | | | | 1,073 |
| 1822 | 1,480 | 39.79 | 2,240 | 60.21 | | | 3,720 |
| 1823 | 1,128 | 16.23 | 5,823 | 83.77 | | | 6,951 |
| 1824 | 1,567 | 14.10 | 9,541 | 85.90 | | | 11,108 |
| 1825 | 6,500 | 18.60 | 28,333 | 81.40 | | | 34,833 |
| 1826 | 16,767 | 34.90 | 31,280 | 65.10 | | | 48,047 |
| 1827 | 31,360 | 49.44 | 32,074 | 50.56 | | | 63,434 |
| 1828 | 47,284 | 61.00 | 30,232 | 39.00 | | | 77,516 |
| 1829 | 79,973 | 71.35 | 25,110 | 22.40 | 7,000 | 6.25 | 112,083 |
| 1830 | 89,984 | 51.50 | 41,750 | 23.90 | 43,000 | 24.60 | 174,734 |
| 1831 | 81,854 | 46.29 | 40,966 | 23.17 | 54,000 | 30.54 | 176,820 |
| 1832 | 209,271 | 57.61 | 70,000 | 19.27 | 84,000 | 23.12 | 363,271 |
| 1833 | 252,971 | 51.87 | 123,001 | 25.22 | 111,777 | 22.91 | 487,749 |
| 1834 | 226,692 | 60.19 | 106,244 | 28.21 | 43,700 | 11.60 | 376,636 |
| 1835 | 339,508 | 60.54 | 131,250 | 23.41 | 90,000 | 16.05 | 560,758 |
| 1836 | 432,045 | 63.16 | 148,211 | 21.66 | 103,861 | 15.18 | 684,117 |
| 1837 | 530,152 | 60.98 | 223,902 | 25.75 | 115,387 | 13.27 | 869,441 |
| 1838 | 446,875 | 60.49 | 213,615 | 28.92 | 78,207 | 10.59 | 738,697 |
| 1839 | 475,077 | 58.05 | 221,025 | 27.01 | 122,300 | 14.94 | 818,402 |
| 1840 | 490,596 | 56.75 | 225,313 | 26.07 | 148,470 | 17.18 | 864,379 |
| 1841 | 624,466 | 65.07 | 143,037 | 14.90 | 192,270 | 20.03 | 959,773 |
| 1842 | 583,273 | 52.62 | 272,540 | 24.59 | 252,599 | 22.79 | 1,108,412 |
| 1843 | 710,200 | 56.21 | 267,793 | 21.19 | 285,605 | 22.60 | 1,263,598 |
| 1844 | 887,937 | 54.45 | 377,002 | 23.12 | 365,911 | 22.43 | 1,630,850 |
| 1845 | 1,131,724 | 56.22 | 429,453 | 21.33 | 451,836 | 22.45 | 2,013,013 |

*Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1907, in long tons*—Continued.

| Year. | Schuylkill region. | | Lehigh region. | | Wyoming region. | | Total. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. |
| 1846 | 1,308,500 | 55.82 | 517,116 | 22.07 | 518,389 | 22.11 | 2,344,005 |
| 1847 | 1,665,735 | 57.79 | 633,507 | 21.98 | 583,067 | 20.23 | 2,882,309 |
| 1848 | 1,733,721 | 56.12 | 670,321 | 21.70 | 685,196 | 22.18 | 3,089,238 |
| 1849 | 1,728,500 | 53.30 | 781,556 | 24.10 | 732,910 | 22.60 | 3,242,966 |
| 1850 | 1,840,620 | 54.80 | 690,456 | 20.56 | 827,823 | 24.64 | 3,358,899 |
| 1851 | 2,328,525 | 52.34 | 964,224 | 21.68 | 1,156,167 | 25.98 | 4,448,916 |
| 1852 | 2,636,835 | 52.81 | 1,072,136 | 21.47 | 1,284,500 | 25.72 | 4,993,471 |
| 1853 | 2,665,110 | 51.30 | 1,054,309 | 20.29 | 1,475,732 | 28.41 | 5,195,151 |
| 1854 | 3,191,670 | 53.14 | 1,207,186 | 20.13 | 1,603,478 | 26.73 | 6,002,334 |
| 1855 | 3,552,943 | 53.77 | 1,284,113 | 19.43 | 1,771,511 | 26.80 | 6,608,567 |
| 1856 | 3,603,029 | 52.91 | 1,351,970 | 19.52 | 1,972,581 | 28.47 | 6,927,580 |
| 1857 | 3,373,797 | 50.77 | 1,318,541 | 19.84 | 1,952,603 | 29.39 | 6,644,941 |
| 1858 | 3,273,245 | 47.86 | 1,380,030 | 20.18 | 2,186,094 | 31.96 | 6,839,369 |
| 1859 | 3,448,708 | 44.16 | 1,628,311 | 20.86 | 2,731,236 | 34.98 | 7,808,255 |
| 1860 | 3,749,632 | 44.04 | 1,821,674 | 21.40 | 2,941,817 | 34.56 | 8,513,123 |
| 1861 | 3,160,747 | 39.74 | 1,738,377 | 21.85 | 3,055,140 | 38.41 | 7,954,264 |
| 1862 | 3,372,583 | 42.86 | 1,351,054 | 17.17 | 3,145,770 | 39.97 | 7,869,407 |
| 1863 | 3,911,683 | 40.90 | 1,894,713 | 19.80 | 3,759,610 | 39.30 | 9,566,006 |
| 1864 | 4,161,970 | 40.89 | 2,054,669 | 20.19 | 3,960,836 | 38.92 | 10,177,475 |
| 1865 | 4,356,959 | 45.14 | 2,040,913 | 21.14 | 3,254,519 | 33.72 | 9,652,391 |
| 1866 | 5,787,902 | 45.56 | 2,179,364 | 17.15 | 4,736,616 | 37.29 | 12,703,882 |
| 1867 | 5,161,671 | 39.74 | 2,502,054 | 19.27 | 5,325,000 | 40.99 | 12,988,725 |
| 1868 | 5,330,737 | 38.52 | 2,502,582 | 18.13 | 5,968,146 | 43.25 | 13,801,465 |
| 1869 | 5,775,138 | 41.66 | 1,949,673 | 14.06 | 6,141,369 | 44.28 | 13,866,180 |
| 1870 | 4,968,157 | 30.70 | 3,239,374 | 20.02 | 7,974,660 | 49.28 | 16,182,191 |
| 1871 | 6,552,772 | 41.74 | 2,235,707 | 14.24 | 6,911,242 | 44.02 | 15,699,721 |
| 1872 | 6,694,890 | 34.03 | 3,873,339 | 19.70 | 9,101,549 | 46.27 | 19,669,778 |
| 1873 | 7,212,601 | 33.97 | 3,705,596 | 17.46 | 10,309,755 | 48.57 | 21,227,952 |
| 1874 | 6,866,877 | 34.09 | 3,773,836 | 18.73 | 9,504,408 | 47.18 | 20,145,121 |
| 1875 | 6,281,712 | 31.87 | 2,834,605 | 14.38 | 10,596,155 | 53.75 | 19,712,472 |
| 1876 | 6,221,934 | 33.63 | 3,854,919 | 20.84 | 8,424,158 | 45.53 | 18,501,011 |
| 1877 | 8,195,042 | 39.35 | 4,332,760 | 20.80 | 8,300,377 | 39.85 | 20,828,179 |
| 1878 | 6,282,226 | 35.68 | 3,237,449 | 18.40 | 8,085,587 | 45.92 | 17,605,262 |
| 1879 | 8,960,829 | 34.28 | 4,595,567 | 17.58 | 12,586,293 | 48.14 | 26,142,689 |
| 1880 | 7,554,742 | 32.23 | 4,463,221 | 19.05 | 11,419,279 | 48.72 | 23,437,242 |
| 1881 | 9,253,958 | 32.46 | 5,294,676 | 18.58 | 13,951,383 | 48.96 | 28,500,017 |
| 1882 | 9,459,288 | 32.48 | 5,689,437 | 19.54 | 13,971,371 | 47.98 | 29,120,096 |
| 1883 | 10,074,726 | 31.69 | 6,113,809 | 19.23 | 15,604,492 | 49.08 | 31,793,027 |
| 1884 | 9,478,314 | 30.85 | 5,562,226 | 18.11 | 15,677,753 | 51.04 | 30,718,293 |
| 1885 | 9,488,426 | 30.01 | 5,898,634 | 18.65 | 16,236,470 | 51.34 | 31,623,530 |
| 1886 | 9,381,407 | 29.19 | 5,723,129 | 17.80 | 17,031,826 | 52.82 | 32,136,362 |
| 1887 | 10,609,028 | 30.63 | 4,347,061 | 12.55 | 19,684,929 | 56.82 | 34,641,018 |
| 1888 | 10,654,116 | 27.93 | 5,639,236 | 14.78 | 21,852,366 | 57.29 | 38,145,718 |
| 1889 | 10,486,185 | 29.28 | 6,294,073 | 17.57 | 19,036,835 | 53.15 | 35,817,093 |
| 1890 | 10,867,822 | 29.68 | 6,329,658 | 17.28 | 19,417,979 | 53.04 | 36,615,459 |
| 1891 | 12,741,258 | 31.50 | 6,381,838 | 15.78 | 21,325,240 | 52.72 | 40,448,336 |
| 1892 | 12,626,784 | 30.14 | 6,451,076 | 15.40 | 22,815,480 | 54.46 | 41,893,340 |
| 1893 | 12,357,444 | 28.68 | 6,892,352 | 15.99 | 23,839,741 | 55.33 | 43,089,537 |
| 1894 | 12,035,005 | 29.08 | 6,705,434 | 16.20 | 22,650,761 | 54.72 | 41,391,200 |
| 1895 | 14,269,932 | 30.68 | 7,298,124 | 15.69 | 24,943,421 | 56.63 | 46,511,477 |
| 1896 | 13,097,571 | 30.34 | 6,490,441 | 15.03 | 23,589,473 | 54.63 | 43,177,485 |
| 1897 | 12,181,061 | 29.26 | 6,249,540 | 15.00 | 23,207,263 | 55.74 | 41,637,864 |
| 1898 | 12,078,875 | 28.83 | 6,253,109 | 14.92 | 23,567,767 | 56.25 | 41,899,751 |
| 1899 | 14,199,009 | 29.79 | 6,887,909 | 14.45 | 26,578,286 | 55.76 | 47,665,204 |
| 1900 | 13,502,732 | 29.94 | 6,918,627 | 15.33 | 24,686,125 | 54.73 | 45,107,484 |
| 1901 | 16,019,591 | 29.92 | 7,211,974 | 13.45 | 30,337,036 | 56.63 | 53,568,601 |
| 1902 | 8,471,391 | 27.15 | 3,470,736 | 11.12 | 19,258,763 | 61.73 | 31,200,890 |
| 1903 | 16,474,790 | 27.75 | 7,164,783 | 12.07 | 35,723,258 | 60.18 | 59,362,831 |
| 1904 | 16,379,293 | 28.49 | 7,107,220 | 12.36 | 34,006,009 | 59.15 | 57,492,522 |
| 1905 | 17,703,099 | 28.83 | 7,849,205 | 12.78 | 35,857,897 | 58.39 | 61,410,201 |
| 1906 | 16,011,285 | 28.75 | 7,046,617 | 12.65 | 32,640,693 | 58.60 | 55,698,595 |
| 1907 | 20,141,288 | 30.01 | 8,329,653 | 12.41 | 38,638,452 | 57.58 | 67,109,393 |
| Total | 504,654,104 | 32.39 | 249,537,032 | 16.02 | 803,664,565 | 51.59 | 1,557,855,701 |

A tabular arrangement of the various sections of the anthracite fields is given below, and a list of the railroads entering the territory.

*Anthracite coal fields, by field, local district, and trade region.*

| Coal field or basin. | Local district. | Trade region. |
|---|---|---|
| Northern | Carbondale | Wyoming. |
| | Scranton | |
| | Pittston | |
| | Wilkes-Barre | |
| | Plymouth | |
| | Kingston | |
| Eastern middle | Green Mountain | Lehigh. |
| | Black Creek | |
| | Hazleton | |
| | Beaver Meadow | |
| | Panther Creek | |
| Southern | East Schuylkill | Schuylkill. |
| | West Schuylkill | |
| | Lorberry | |
| | Lykens Valley | |
| Western middle | East Mahanoy | |
| | West Mahanoy | |
| | Shamokin | |

The above-named fields comprise an area of somewhat more than 480 square miles and are located in the eastern-middle part of the State, in the counties of Carbon, Columbia, Lackawanna, Luzerne, Northumberland, Schuylkill, and Susquehanna, and are classed under three general divisions, viz, Wyoming, Lehigh, and Schuylkill regions. Geologically they are divided into fields or basins, which are again subdivided into districts.

The Bernice field, in Sullivan County, is not included in any of these regions. The classification of the product of this field is a matter of much contention. The fracture of the coal and some of its physical characteristics are more like some bituminous or semianthracite coals than strict anthracite, but on account of its high percentage of fixed carbon and low percentage of moisture it is classed as anthracite by the Second Pennsylvania Geological Survey, and the product is so included in this report.

The tonnage from this field is not included in the shipments by regions nor in the division according to sizes.

The above territory is reached by ten so-called initial railroads, as follows:

Philadelphia and Reading Railway Company.
Lehigh Valley Railroad Company.
Central Railroad of New Jersey.
Delaware, Lackawanna and Western Railroad Company.
Delaware and Hudson Company's Railroad.
Pennsylvania Railroad Company.
Erie Railroad Company.
New York, Ontario and Western Railroad Company.
Delaware, Susquehanna and Schuylkill Railroad Company.[a]
New York, Susquehanna and Western Railroad Company.[b]

### PENNSYLVANIA BITUMINOUS COAL.

Total production in 1907, 150,143,177 short tons; spot value, $155,664,026.

In the production of bituminous coal alone, Pennsylvania far outranks any of the other coal-producing States, the output in 1907 being nearly three times that of Illinois, which was the second coal-producing State, and exceeding the combined production of Illinois, West Virginia, Ohio, and Alabama, whose aggregate production in 1907 amounted to 145,801,602 short tons. Compared with 1906, which was in itself a record-breaking year (as was also 1905), the production of bituminous coal in Pennsylvania showed an increase of 20,849,971 tons, or 16.13 per cent in quantity, and of $25,373,375, or 19.47 per cent in value. One county in the State (Cambria) showed an increase of over 4,000,000 tons, and three others (Clearfield, Fayette, and Indiana) each increased more than 2,000,000 tons. Four counties (Allegheny, Somerset, Washington, and Westmoreland) showed increases of more than 1,000,000 tons each. Only one county (Lawrence) showed a decrease in production, and in this the loss was comparatively insignificant. The combined production of Fayette and Westmoreland counties, in which is located the famous Connellsville coking district, amounted to over 58,000,000 tons, an amount larger by 7,000,000 tons than the total production of Illinois. Fayette County produced a little over 29,000,000 tons, and Westmoreland County a little less than that quantity.

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[a] Part of Lehigh Valley system.

[b] Part of Erie system.

At practically all of the mines of the bituminous district of Pennsylvania during the greater part of the year there was an unprecedented shortage of miners and other employees, as well as a marked shortage of railroad cars. If, however, there had been no scarcity of miners and cars, it is believed that many of the mines would have been compelled to run on reduced time, particularly in central Pennsylvania, as the development has increased so rapidly within the last few years that it would have required even greater industrial demand than existed in 1907 to keep all of the mines running to their full capacity. The increase of nearly 35 per cent in the production of Cambria and Clearfield counties, and of 60 per cent in the production of Indiana County, shows to what an extent the development in central Pennsylvania progressed. The scarcity of cars enabled the producers to maintain prices during the summer at the highest level known in normal times, and the business was undoubtedly the most profitable Pennsylvania operators had known during a summer season. With the monetary troubles in October, the demand for coal fell off and prices naturally "slumped," the operators finding it difficult to get rid of any but the highest and best-known grades.

Of the total production in 1907, 60,771,157 short tons, or 40.48 per cent was undercut by machines, while in 1906, 54,146,314 short tons, or 41.88 per cent of the total product, was undercut by machines. The number of machines in use in 1907 was 4,940, of which 3,372 were of the pick or puncher type, 1,547 were chain-breast, and 21 were long-wall.

The total number of men employed in the bituminous coal mines of Pennsylvania in 1907 was 163,295, who worked an average of 255 days, against 152,099 men for an average of 231 days in 1906. The average production per man per year was 919.5 tons in 1907, against 850.1 tons in 1906 and 824.4 tons in 1905. The average daily production per man, which increased from 3.57 tons in 1905 to 3.68 tons in 1906, fell off to 3.61 tons in 1907.

The majority of the bituminous mines in Pennsylvania are operated on the basis of an 8-hour day. Of the 163,295 men employed in 1907, 96,667, employed in 812 mines, worked 8 hours a day; 260 mines, employing 24,883 men, worked 9 hours a day, and 198 mines, employing 35,355 men, worked 10 hours. There were 6,390 men whose working hours were not reported.

Labor disturbances in the bituminous mines in Pennsylvania in 1907 were not sufficient to affect the production, such strikes as occurred affecting comparatively few men and being of short duration. The total number of men idle on account of strikes was 6,447, or 4 per cent of the total number employed, and the average number of days idle for each man was 9.

The casualty record for the bituminous mines of Pennsylvania, as reported by Mr. James E. Roderick, chief of the department of mines, at Harrisburg, shows that in 1907 there were 806 men killed and 1,207 injured, as compared with 477 killed and 1,160 injured in 1906. Of the total number of deaths, 40 were outside the mines and 766 inside; 63 of the injuries were received outside the mines and 1,144 inside. The number of deaths due to explosions of gas or mixtures of gas and dust was unusually large, the disasters at Naomi and Darr, both of which occurred in December, being responsible for the large fatality record in this respect. The total number of deaths from this cause was 276, but notwithstanding this unusually large number of victims to explosions the record of those killed by falls of roof or coal was larger, there being 307 deaths from this cause. There were 102 deaths due to men being crushed by cars in the mines, and 15 were killed by powder explosions or windy shots. Twenty men were killed by being run over by cars outside the mines, and 19 by falling into shafts and slopes. In addition to the men killed by falls of coal, there were 593 injured from this cause, while accidents from the cars resulted in 383 injuries, 345 of which were in the mines and 38 outside. As showing the fatal character of explosions in the mines, the number of injuries from this cause was only 10 per cent of the number of deaths, being 27 injured and 276 killed; while in the falls of roof or coal and the car accidents and accidents from powder explosions and windy shots the number injured greatly exceeded that of the killed. The death rate per thousand men employed in the bituminous mines of Pennsylvania in 1907 was 4.94, and the number of tons mined for each life lost was 186,281.. In 1906 the death rate per thousand was 3.14, and the number of tons mined for each life lost was 271,055.

The statistics of production, by counties, with the distribution of the product for consumption in 1906 and 1907 are shown in the following tables:

*Bituminous coal production of Pennsylvania in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Allegheny | 16,190,981 | 389,151 | 242,895 | .......... | 16,823,027 | $17,288,960 | $1.03 | 236 | 19,754 |
| Armstrong | 2,433,082 | 51,182 | 81,900 | 8,594 | 2,574,758 | 2,488,887 | .97 | 230 | 3,891 |
| Beaver | 48,415 | 31,525 | 1,591 | .......... | 81,531 | 110,091 | 1.35 | 214 | 180 |
| Bedford | 561,866 | 7,249 | 10,129 | 155,611 | 734,855 | 744,011 | 1.01 | 175 | 1,515 |
| Blair | 134,540 | 184,735 | 4,544 | 78,619 | 402,438 | 451,692 | 1.12 | 244 | 624 |
| Butler | 784,939 | 7,101 | 11,459 | .......... | 803,499 | 805,698 | 1.00 | 220 | 1,326 |
| Cambria | 10,758,269 | 227,938 | 247,454 | 1,205,491 | 12,439,152 | 13,334,190 | 1.07 | 203 | 19,902 |
| Center | 884,115 | 8,468 | 1,849 | 1,002 | 895,434 | 842,076 | .94 | 145 | 1,766 |
| Clarion | 679,980 | 21,969 | 17,599 | .......... | 719,548 | 697,866 | .97 | 159 | 1,569 |
| Clearfield | 5,484,154 | 69,582 | 138,595 | 252,414 | 5,944,745 | 5,746,030 | .97 | 170 | 11,556 |
| Elk | 864,581 | 5,194 | 17,258 | 57,334 | 944,367 | 944,682 | 1.00 | 161 | 2,119 |
| Fayette | 7,638,901 | 277,991 | 519,098 | 18,608,461 | 27,044,451 | 27,141,727 | 1.00 | 209 | 21,239 |
| Huntingdon | 613,334 | 7,044 | / 9,777 | .......... | 630,155 | 697,543 | 1.11 | 252 | 1,028 |
| Indiana | 4,317,122 | 27,957 | 86,289 | 226,089 | 4,657,457 | 4,292,656 | .92 | 211 | 7,179 |
| Jefferson | 3,873,829 | 17,754 | 103,014 | 1,165,598 | 5,160,195 | 4,608,049 | .89 | 189 | 6,795 |
| Lawrence | 221,673 | 24,510 | 11,533 | .......... | 257,716 | 304,882 | 1.18 | 237 | 450 |
| Mercer | 805,869 | 5,289 | 31,490 | .......... | 842,648 | 914,019 | 1.08 | 222 | 1,410 |
| Somerset | 6,417,721 | 32,113 | 183,050 | 41,307 | 6,674,191 | 7,237,817 | 1.08 | 248 | 8,529 |
| Tioga | 785,849 | 34,702 | 6,374 | .......... | 826,925 | 1,230,072 | 1.49 | 176 | 2,106 |
| Washington | 12,174,377 | 66,726 | 284,431 | 188,871 | 12,714,405 | 12,929,442 | 1.02 | 243 | 13,539 |
| Westmoreland | 17,771,320 | 244,390 | 551,243 | 9,006,467 | 27,573,420 | 26,828,203 | .97 | 278 | 24,768 |
| Other counties[a] and small mines | 459,887 | 49,319 | 8,747 | 30,336 | 548,289 | 652,058 | 1.19 | 216 | 854 |
| Total | 93,904,804 | 1,791,889 | 2,570,319 | 31,026,194 | 129,293,206 | 130,290,651 | 1.00 | 231 | 152,099 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Allegheny | 17,686,649 | 336,922 | 292,165 | .......... | 18,315,736 | $20,110,460 | $1.10 | 250 | 21,085 |
| Armstrong | 3,230,135 | 75,925 | 114,018 | 9,924 | 3,430,002 | 3,428,258 | 1.00 | 246 | 5,125 |
| Beaver | 71,200 | 37,025 | 1,350 | .......... | 109,575 | 140,613 | 1.28 | 246 | 185 |
| Bedford | 721,242 | 9,718 | 11,974 | 224,379 | 967,313 | 999,828 | 1.03 | 236 | 1,439 |
| Blair | 393,011 | 2,273 | 6,801 | 91,134 | 493,219 | 508,856 | 1.03 | 285 | 693 |
| Butler | 878,710 | 11,462 | 12,557 | .......... | 902,729 | 958,051 | 1.06 | 256 | 1,380 |
| Cambria | 14,403,319 | 277,526 | 325,452 | 1,520,324 | 16,526,621 | 17,393,367 | 1.05 | 260 | 20,964 |
| Center | 1,239,450 | 6,116 | 3,830 | 6,987 | 1,256,383 | 1,151,866 | .92 | 226 | 1,738 |
| Clarion | 1,040,176 | 11,051 | 27,140 | .......... | 1,078,367 | 1,100,433 | 1.02 | 224 | 1,913 |
| Clearfield | 7,393,066 | 117,242 | 166,680 | 357,723 | 8,034,711 | 7,887,283 | .98 | 229 | 10,890 |
| Elk | 1,312,169 | 34,370 | 23,293 | 58,009 | 1,427,841 | 1,402,096 | 1.01 | 251 | 2,003 |
| Fayette | 7,243,548 | 321,578 | 553,786 | 21,141,710 | 29,260,622 | 30,321,657 | 1.04 | 270 | 22,909 |
| Huntingdon | 676,327 | 7,519 | 11,363 | 26,395 | 721,604 | 798,115 | 1.11 | 268 | 1,081 |
| Indiana | 6,973,163 | 41,217 | 145,628 | 311,249 | 7,471,257 | 7,068,510 | .95 | 250 | 9,531 |
| Jefferson | 4,536,052 | 28,944 | 112,966 | 1,286,435 | 5,964,397 | 5,712,576 | .96 | 251 | 6,894 |
| Lawrence | 183,646 | 22,983 | 14,089 | .......... | 220,718 | 294,786 | 1.34 | 271 | 385 |
| Mercer | 909,496 | 7,918 | 37,876 | .......... | 955,290 | 1,041,137 | 1.09 | 260 | 1,487 |
| Somerset | 7,407,835 | 46,676 | 207,806 | 107,391 | 7,769,708 | 8,579,132 | 1.10 | 263 | 9,835 |
| Tioga | 1,096,637 | 40,925 | 8,791 | .......... | 1,146,353 | 1,768,394 | 1.54 | 241 | 2,178 |
| Washington | 13,741,410 | 96,840 | 342,204 | 355,273 | 14,535,727 | 15,612,757 | 1.07 | 246 | 15,033 |
| Westmoreland | 18,341,804 | 332,461 | 613,200 | 9,629,256 | 28,916,721 | 28,618,176 | .99 | 266 | 25,676 |
| Other counties[b] and small mines | 530,628 | 74,441 | 7,214 | 26,000 | 638,283 | 727,675 | 1.14 | 252 | 871 |
| Total | 110,009,673 | 1,941,132 | 3,040,183 | 35,152,189 | 150,143,177 | 155,664,026 | 1.04 | 255 | 163,295 |

[a] Cameron, Clinton, Greene, and Lycoming.
[b] Bradford, Cameron, Clinton, Greene, Lycoming, and McKean.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Bituminous coal production of Pennsylvania, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Allegheny | 12,689,225 | 12,291,261 | 13,662,610 | 16,823,027 | 18,315,736 | + 1,492,709 |
| Armstrong | 1,920,584 | 1,906,661 | 2,497,314 | 2,574,758 | 3,430,002 | + 855,244 |
| Beaver | 180,102 | 67,923 | 82,676 | 81,531 | 109,575 | + 28,044 |
| Bedford | 926,334 | 540,850 | 752,715 | 734,855 | 967,313 | + 232,458 |
| Blair | 309,736 | 244,932 | 348,749 | 402,438 | 493,219 | + 90,781 |
| Butler | 649,033 | 497,316 | 550,589 | 803,499 | 902,729 | + 99,230 |
| Cambria | 10,942,496 | 10,845,560 | 12,600,891 | 12,439,152 | 16,526,621 | + 4,087,469 |
| Center | 759,458 | 712,036 | 810,441 | 895,434 | 1,256,383 | + 360,949 |
| Clarion | 531,630 | 551,532 | 714,478 | 719,548 | 1,078,367 | + 358,819 |
| Clearfield | 7,462,682 | 5,746,870 | 7,248,305 | 5,944,745 | 8,034,711 | + 2,089,966 |
| Clinton | 403,543 | 341,967 | 296,988 | 233,674 | 322,624 | + 88,950 |
| Elk | 1,339,281 | 1,129,231 | 1,249,337 | 944,367 | 1,427,841 | + 483,474 |
| Fayette | 19,613,161 | 19,231,011 | 24,250,989 | 27,044,451 | 29,260,622 | + 2,216,171 |
| Greene | 153,000 | 80,646 | 105,000 | 144,251 | 158,187 | + 13,936 |
| Huntingdon | 500,647 | 487,223 | 559,039 | 630,155 | 721,604 | + 91,449 |
| Indiana | 2,043,140 | 2,683,951 | 4,477,431 | 4,657,457 | 7,471,257 | + 2,813,800 |
| Jefferson | 6,474,764 | 6,043,564 | 6,393,985 | 5,160,195 | 5,964,397 | + 804,202 |
| Lawrence | 232,992 | 182,662 | 267,470 | 257,716 | 220,718 | − 36,998 |
| Lycoming | 57,030 | 78,837 | 33,844 | 44,425 | 51,956 | + 7,531 |
| Mercer | 704,747 | 619,648 | 707,964 | 842,648 | 955,290 | + 112,642 |
| Somerset | 5,957,751 | 5,317,161 | 6,412,672 | 6,674,191 | 7,769,708 | + 1,095,517 |
| Tioga | 905,688 | 616,828 | 706,723 | 826,925 | 1,146,353 | + 319,428 |
| Washington | 9,216,267 | 8,900,254 | 10,609,051 | 12,714,405 | 14,535,727 | + 1,821,322 |
| Westmoreland | 19,127,904 | 18,688,974 | 22,998,726 | 27,573,420 | 28,916,721 | + 1,343,301 |
| Small mines | [a] 15,983 | [a] 41,389 | [a] 75,650 | [a] 125,939 | [b] 105,516 | − 20,423 |
| Total | 103,117,178 | 97,938,287 | 118,413,637 | 129,293,206 | 150,143,177 | + 20,849,971 |
| Total value | $121,752,759 | $94,428,219 | $113,390,507 | $130,290,651 | $155,664,026 | +$25,373,375 |

[a] Includes production of Cameron County.

[b] Includes production of Bradford, Cameron, and McKean counties.

The bituminous coal field of Pennsylvania includes an area of about 14,200 square miles in the western part of the State. The coal-bearing rocks lie in the form of a number of canoe-shaped troughs extending northeast and southwest. There are 6 or more of these troughs, and they lie at successively lower levels in going toward the Ohio River from either the east or the west, the whole tending to form a major shallow trough, whose axis runs roughly from Pittsburg to Huntington, W. Va. The folds diminish in strength in going westward from the Allegheny front. Around the rim of the major trough occur the outcrops of the lower measures; in the center the lower measures are deeply buried, and the exposed rocks belong to the upper measures.

The coal-bearing rocks all belong to the Pennsylvanian series, and have a total thickness in the southwest corner of the State of about 2,600 feet. The great bulk of the coal mined comes from the Allegheny and Monongahela formations, formerly known as the Lower and the Upper Productive Measures. Below the Allegheny formation is the Pottsville, containing the Sharon and the Mercer coals, which reach workable thickness only very locally. The Allegheny or "Lower Productive Measures," with a thickness of 250 to 350 feet, contain at least 7 coal horizons, all of which yield workable coal locally. They are called, beginning at the bottom, the Brookville, Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport coals. It is now definitely recognized that the coals of these horizons do not occur in continuous beds, and in many cases not in exactly the same horizons. As a rule, they are not characterized by details of section, roof, or floor, so that they can not be clearly recognized, except over limited parts of the field. No one of them is continuously workable, but the Lower Kittanning and the Upper Freeport coals are widely workable, and the Lower Freeport has a splendid development over several counties in the northeast part of the field. The Brookville or "A" coal is of workable thickness in spots over a large part of the marginal belt of the coal measures, especially in Jefferson, Clearfield, Center, Cambria, and Somerset counties. The Clarion or "A′" coal reaches workable thickness in about the same belt, though the two are seldom of workable thickness in the same section. Both of these coals are apt to be impure when thick. The Lower Kittanning or "B" coal is the most persistent, uniform, and reliable of the Allegheny coals, although it is thinner than the Freeport coals, seldom exceeding a thickness of 4 feet. It is exposed in workable thickness and purity in 11 of the counties. The Middle and the Upper Kittanning horizons, "C" and "C′," contain but little workable coal, though the Upper Kittanning shows cannel coal at a number of points and stands forth in productivity. The Lower Freeport coal, "D," is finely developed in Clearfield, Jefferson, Indiana, and Cambria counties—in the well-known Moshannon (Clearfield), Reynoldsville-Punxsutawney, and Barnesboro-Patton basins. Over most of the rest of the territory this seam is either worthless or of too low grade for competition in the present market. The Upper Freeport or coal "E" is a variable and complex bed, extending in gross workable thickness over most of its area, although over a considerable part of this territory it is too much broken up and too impure for profitable mining. It appears to be entirely absent in some localities.

As a whole, the Allegheny formation yields about 40 per cent of the total output of bituminous coal in the State.

For about 600 feet above the Upper Freeport bed occurs the Conemaugh formation, or "Lower Barren Measures." It contains 6 or more coals, which, however, are only very locally workable.

Just over the top of this formation comes the Pittsburg coal, the most uniform in quality and thickness, and for a given area the most valuable coal bed in the bituminous field of Pennsylvania. Although not of as high a grade as the best Allegheny coals to the east, and although varying greatly in quality from east to west, on the whole the Pittsburg coal, on account of its thickness, its regularity, its high grade, and its adaptability for the production of coke and illuminating gas, has long been the most famous bituminous coal bed in America. It is confined to the southwestern part of the State. The bed will give 9 feet of available coal over large areas, and seldom runs under 4 feet. Above the Pittsburg coal occur the Redstone, Sewickley, Uniontown, and Waynesburg coals, which are of good workable thickness locally, but in the presence of the great Pittsburg coal are but little mined.

The statistics of the early production of bituminous coal in Pennsylvania, particularly as compared with the anthracite records, are sadly wanting. The United States census of 1840 shows a production of bituminous coal in the State of 464,826 short tons. The census of 1860 reports a production of 2,690,786 short tons; that of 1870 shows a production of 7,798,518 short tons. The production for the intervening years, as shown on the table on a preceding page, has been estimated from the best information obtainable. Since 1871 the records are official. The total production of bituminous coal, as shown by the above-mentioned table, has amounted to 1,846,069,253 short tons. The anthracite production from 1814 to the close of 1907 has amounted to 1,931,510,321 short tons, showing that the total production for the State has been nearly evenly divided between anthracite and bituminous coal.

Mr. Campbell places the amount of coal originally in the anthracite fields of Pennsylvania at 21,000,000,000 short tons, and in the bituminous fields at 112,574,000,000 short tons. Under the conditions in which mining in the anthracite region was carried on in former years, it was estimated that for every ton of coal mined and marketed, 1½ tons approximately were either wasted or left in the ground as pillars for the protection of the workings, so that the actual yield of the beds was only about 40 per cent of the contents. This percentage of waste has been materially reduced by modern methods of mining, but it is probable that the exhaustion to the close of 1907 has actually doubled the production, or, say, 4,000,000,000 short tons. This would leave still in the ground approximately 17,000,000,000 tons, which would be capable of producing, at the rate of 1 ton of coal lost for each ton mined, 8,500,000,000, or approximately 100 times the quantity of anthracite produced in 1907. If all of the coal were to be recovered the supply would last two hundred years at the rate of production in 1907. The quantity of anthracite which would actually be produced would probably lie somewhere between half the remaining supply and the total.

Estimating for the bituminous production 1 ton of coal lost for every 2 tons mined, the exhaustion to the close of 1907 has been 2,760,000,000 tons, which would leave still in the ground a little less than 110,000,000,000 short tons—about 730 times the production of 1907—or, in other words, if the exhaustion is 1½ times the production of bituminous coal of Pennsylvania, at the rate of production in 1907 the supply would last approximately four hundred and ninety years.

### TENNESSEE.

Total production in 1907, 6,810,243 short tons; spot value, $8,490,334.

Tennessee participated in the general increased production in 1907, but to a less extent than many of the other eastern States. Coal mining is confined to the eastern portion of the State, which is crossed by the Appalachian system, and mining operations are carried on under the handicap of having their markets in common, and accordingly competitive, with the coals from Alabama and southern Kentucky. About 40 per cent of the output of Tennessee is used for railroad fuel, and about 15 per cent is absorbed by a comparatively restricted local market—that is, in eastern Tennessee. The remainder of the product goes to the competitive markets of Tennessee, Kentucky, Georgia, and North and South Carolina.

In addition to the mild weather of November and December, which caused a decrease in the demand for coal for domestic purposes, the monetary disturbances so affected the iron market that coke could not be sold at a profit. This forced many of the large mines in Virginia, West Virginia, Alabama, and Tennessee to market as steam coal the portion of the product which had previous to that time been coked. This added competition had a demoralizing influence upon the Tennessee operations in the last three months of the year.

The net results of the coal-mining operations in Tennessee in 1907 was an increase of 550,968 short tons, or 8.8 per cent in quantity over the output of 1906, with a gain of $822,919, or 10.73 per cent in value, and as in most of the coal-producing States, the maximum production was recorded. The average price per ton advanced from $1.22 in 1906 to $1.25 in 1907. There were employed in the coal mines of Tennessee in 1907, 12,052 men, who worked an average of 232 days, compared with 11,452 men, working an average of 229 days in 1906. The increase in the productive efficiency of the mine employees, as referred to in the report for 1906, continued in 1907, the average production per man having increased from 483.5 in 1905 to 546.6 in 1906 and to 565 in 1907. The average daily production of each man has increased from 2.29 in 1905 to 2.39 in 1906 and to 2.44 in 1907.

The increased efficiency is attributable in part to the larger number of mining machines employed and to the larger tonnage won by them. In 1905 there were 89 machines in use in the coal mines of Tennessee, and the machine-mined product amounted to 479,471 short tons. In 1906 there were 128 machines in use, with a machine-mined tonnage of 747,500. In 1907 there were 874,925 tons of coal produced by the use of 137 machines. The total quantity of machine-mined coal in 1907 represented 12.85 per cent of the total production, against 12 per cent in 1906. Of the 137 machines in use in 1907, 120 were pick or puncher machines, 14 of the chain-breast, and 3 of the long-wall type.

The statistics relative to the length of working days show that 58 per cent of the total number of men employed in the mines of Tennessee worked nine hours a day. In 1907, 6,968 men distributed among 75 mines, out of a total of 12,052 men, worked nine hours and 3,379 in 27 mines worked ten hours. There were 13 mines employing 1,561 men that worked eight hours a day. The ten-hour mines included the State mines at Petros, in Morgan County, which employed 597 convicts in 1907 and 775 in 1906. These mines worked three hundred and ten days in the year. The labor disturbances in 1907 were negligible, the total number of men idle because of strikes being 284 and the average number of days lost seventeen.

Of the total production in 1907, 604,557 tons were washed, yielding 543,333 tons of cleaned coal and 61,224 tons of refuse.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Tennessee in 1906 and 1907, by counties, in short tons.*

**1906.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Anderson | 745,790 | 8,845 | 9,199 | ......... | 763,834 | $913,572 | $1.20 | 187 | 1,488 |
| Campbell | 1,056,928 | 26,594 | 30,507 | 168,078 | 1,282,107 | 1,719,498 | 1.34 | 209 | 2,344 |
| Claiborne | 1,062,527 | 8,517 | 14,865 | 13,838 | 1,099,747 | 1,101,700 | 1.00 | 205 | 1,639 |
| Grundy | 417,572 | 5,315 | 1,125 | 25,355 | 449,367 | 571,005 | 1.27 | 243 | 704 |
| Hamilton | 219,966 | 3,014 | 5,739 | 87,813 | 316,532 | 391,685 | 1.24 | 260 | 600 |
| Marion | 311,178 | 4,894 | 4,843 | 68,610 | 389,525 | 615,211 | 1.58 | 270 | 674 |
| Morgan | 484,274 | 7,369 | 15,569 | 108,493 | 615,705 | 770,286 | 1.25 | 264 | 1,379 |
| Overton | 79,752 | 50 | 1,801 | ......... | 81,603 | 102,770 | 1.26 | 199 | 178 |
| Scott | 162,159 | 3,864 | 2,180 | ......... | 168,203 | 242,179 | 1.44 | 210 | 361 |
| Other counties[a] | 667,908 | 17,673 | 32,223 | 373,648 | 1,091,452 | 1,237,661 | 1.13 | 253 | 2,085 |
| Small mines | ......... | 1,200 | ......... | ......... | 1,200 | 1,848 | 1.54 | ......... | ......... |
| Total | 5,208,054 | 87,335 | 118,051 | 845,835 | 6,259,275 | 7,667,415 | 1.22 | 229 | 11,452 |

**1907.**

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| **Anderson** | 823,389 | 11,108 | 17,446 | ......... | 851,943 | $1,020,293 | $1.20 | 217 | 1,708 |
| **Campbell** | 1,212,252 | 37,764 | 27,435 | 122,549 | 1,400,000 | 1,951,861 | 1.39 | 196 | 2,507 |
| **Claiborne** | 1,113,670 | 14,900 | 19,330 | ......... | 1,147,900 | 1,153,294 | 1.00 | 239 | 1,636 |
| **Grundy** | 526,010 | 2,568 | 2,747 | 33,266 | 564,591 | 637,478 | 1.13 | 270 | 897 |
| **Hamilton** | 284,507 | 7,091 | 7,923 | 82,523 | 382,044 | 510,501 | 1.34 | 241 | 697 |
| **Marion** | 341,515 | 1,535 | 3,969 | 54,397 | 401,416 | 560,006 | 1.39 | 282 | 665 |
| **Morgan** | 520,515 | 5,718 | 10,727 | 102,247 | 639,207 | 838,598 | 1.31 | 264 | 1,199 |
| **Overton** | 73,876 | 320 | 538 | ......... | 74,734 | 97,817 | 1.31 | 234 | 150 |
| **Scott** | 182,387 | 12,142 | 2,636 | ......... | 197,165 | 300,545 | 1.52 | 205 | 474 |
| **Other counties**[a] | 663,867 | 41,708 | 36,902 | 408,620 | 1,151,097 | 1,419,690 | 1.23 | 234 | 2,119 |
| **Small mines** | ......... | 146 | ......... | ......... | 146 | 251 | 1.72 | ......... | ......... |
| **Total** | 5,741,988 | 135,000 | 129,653 | 803,602 | 6,810,243 | 8,490,334 | 1.25 | 232 | 12,052 |

[a] Bledsoe, Cumberland, Fentress, Franklin, Rhea, Roane, Sequatchie, and White.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Tennessee, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Anderson | 655,721 | 630,109 | 845,778 | 763,834 | 851,943 | + 88,109 |
| Campbell | 700,368 | 804,750 | 1,080,540 | 1,282,107 | 1,400,000 | + 117,893 |
| Claiborne | 784,628 | 961,255 | 1,020,453 | 1,099,747 | 1,147,900 | + 48,153 |
| Cumberland | 134,093 | 91,718 | 35,052 | 64,247 | 86,362 | + 22,115 |
| Grundy | 466,642 | 357,219 | 421,210 | 449,367 | 564,591 | + 115,224 |
| Hamilton | 264,268 | 252,735 | 296,445 | 316,532 | 382,044 | + 65,512 |
| Marion | 439,784 | 388,605 | 416,768 | 389,525 | 401,416 | + 11,891 |
| Morgan | 524,485 | 484,232 | 620,587 | 615,705 | 639,207 | + 23,502 |
| Overton | 83,340 | 106,403 | 84,493 | 81,603 | 74,734 | − 6,869 |
| Rhea | 231,689 | 204,992 | 240,590 | 264,918 | 242,421 | − 22,497 |
| Roane | 129,480 | 98,519 | 122,403 | 158,421 | 170,748 | + 12,327 |
| Scott | 142,424 | 123,478 | 140,230 | 168,203 | 197,165 | + 28,962 |
| White | 167,900 | 149,286 | 309,233 | 438,602 | 425,328 | − 13,274 |
| Other counties and small mines | 73,182 | 128,910 | 132,908 | 166,464 | 226,384 | + 59,920 |
| Total | 4,798,004 | 4,782,211 | 5,766,690 | 6,259,275 | 6,810,243 | + 550,968 |
| Total value | $5,979,830 | $5,642,393 | $6,577,881 | $7,667,415 | $8,490,334 | +$822,919 |

About 4,400 square miles of the State are underlain by coal measures, and approximately half this area contains one or more beds of workable coal. The coal measures occupy a belt extending entirely across the State in a northeast-southwest direction. This belt has a width of 70 miles at the Kentucky line, and is there practically continuous. At the Georgia-Alabama line its width is about 50 miles, and only the highest land is occupied by coal measures, the valleys of Tennessee River and its tributaries being cut in "Lower Carboniferous" formations.

The greater part of the workable coal occurs in three basins, the Wartburg, the Walden, and the Sewanee.

The Wartburg basin lies north of Emory River, embracing portions of Scott, Anderson, and Morgan counties. It is continuous northward with the Jellico basin, which lies partly in Tennessee and partly in Kentucky. The central portion of the Wartburg basin is a deeply dissected plateau, and its coal is almost entirely undeveloped. Only two beds are at present worked, and these only about the margins. The higher of these is in the Wartburg sandstone and the lower, probably corresponding with the Sewanee bed, farther south in the underlying Briceville shale. The latter coal bed averages about 4 feet in thickness on the eastern margin of the basin, decreasing to 3 feet at its western edge. There are, in addition to these two, numerous undeveloped beds, several of which are known to be of workable thickness.

The Walden basin extends southwestward from Emory River to the Georgia line. It is a narrow, unsymmetrical syncline, the beds having a steep dip on the eastern and a gentle dip on the western margins. The Walden basin contains several workable coal beds, the most important of which is identified with the Sewanee. The development has thus far been confined chiefly to the eastern margin, where streams flowing from the Walden plateau have cut narrow gorges through the sharply upturned strata, giving access to the lowest part of the syncline.

The Sewanee basin is also long and narrow and extends parallel with the Walden basin, being separated from the latter by the Sequatchie Valley. The strata are practically horizontal except along the margin of the Sequatchie Valley, where they are sharply upturned. This basin contains several coal beds, the most important of which is the Sewanee, which is exceptional for its uniformity of character over a very large area. It averages about 4 feet in thickness. The principal development has been along the western margin of the Sequatchie Valley and in the outliers of the coal bed occupying the summit of the Cumberland Plateau. By far the larger part of the basin is entirely undeveloped.

The workable coal in the three basins described above is chiefly in the Walden formation, above the Lookout conglomerate. Locally, one or more of the three coal beds which occur below the Lookout conglomerate attain workable thickness and the product is highly esteemed as domestic fuel. These lower beds are developed chiefly at Bonair and in the vicinity of South Pittsburg.

The United States census of 1840 states that 558 short tons of coal were produced in Tennessee in that year. It is probable that very little was mined in the State prior to that date. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the civil war. Since 1880 the production of Tennessee has increased quite regularly, but not so rapidly as that of Alabama. The annual production of the State since 1842 is shown in the table on a preceding page, giving the production of coal in the United States from the earliest times to the close of 1907.

The total production of Tennessee to the close of 1907 amounted to 84,304,601 tons, representing an exhaustion of 126,000,000 tons. According to the estimate by Mr. Marius R. Campbell, of the United States Geological Survey, the bituminous coal fields of Tennessee cover an area of 4,400 square miles, the original contents of which when mining began were 25,665,000,000 short tons, of which the exhaustion to the close of 1907 represented a little less than one-half of 1 per cent of the total estimated supply. The coal still left in the ground is about 200 times the exhaustion to the close of 1907; 3,750 times the production in 1907, or 2,500 times the exhaustion represented by that production.

## TEXAS.

Total production in 1907, 1,648,069 short tons; spot value, $2,778,811.

A decrease of over 60 per cent in the production of petroleum in Texas in 1906, as compared with 1905, gave an additional impetus to coal mining in the State and resulted in an increase of 112,189 short tons. The production of Texas petroleum in 1907 was about the same as in 1906, there being an insignificant decrease in the output. There was, however, a decided advance in the price of fuel oil in the State, and this resulted in a number of railroads returning to coal for locomotive use, the effect of which is exhibited in an increase in the production of coal in Texas of 335,196 short tons, or 25.53 per cent in quantity, and of $599,910, or 27.53 per cent in value. The statistical situation in petroleum in Texas is also largely responsible for the increase of over one and a half million tons in the coal production of Arkansas and Oklahoma, whose principal markets are in the Texas territory. The larger portion of the increase in Texas coal production in 1907 was from the lignite-producing areas, the output of lignite having increased from 472,888 short tons in 1906 to 707,732 tons in 1907. There was also a decided advance, from 84 cents to $1.01, in the average price per ton for lignite at the mines, and the total value increased from $399,011 to $715,893. The production of bituminous coal in the State increased from 839,985 short tons in 1906 to 940,337 tons in 1907, with an increase in value of from $1,779,890 to $2,062,918. The average price per ton for bituminous coal also advanced from $2.12 to $2.19. During 1907 the Wichita Falls and Southern Railway Company was reported as having under construction a branch line from Wichita Falls to the bituminous coal areas of Young County. There are stated to be approximately 1,000 acres of coal in Young County, none of which is at present mined on account of lack of railroad transportation. It was expected that the railroad would be completed before the close of the current year.

The bituminous and lignite mines of Texas gave employment in 1907 to a total of 4,227 men who worked an average of 242 days, against 3,048 men for an average of 227 days in 1906. The bituminous mines employed 3,137 men for an average of 255 days in 1907 and the lignite mines 1,090 men for an average of 204 days. The average production per man per day in the bituminous mines was 1.18 and in the lignite mines 3.18. The average daily production per man for both bituminous and lignite was 1.61. The average production per man for the year was 300 in the bituminous mines and 649.3 in the lignite mines, with 390 as the average for the total production for the State.

There were 3 mines in which mining machines were employed in 1907, and 36,100 short tons were mined with the use of 13 machines, against 22,682 tons mined by the use of 12 machines in 1906. In most of the bituminous mines of the State the men worked 8 hours a day, while in the lignite mines the rule is the 10-hour day. In 1907 there were 1,453 men who worked 8 hours a day and 2,202 men who worked 10 hours. One mine employing 60 men reported 9 hours, and there were 512 men whose length of working day was not reported.

There were 16 counties which produced coal or lignite in 1907, an increase of 3 over 1906. Bituminous coal was produced in 7 counties, namely, Erath, McCullough, Maverick, Palo Pinto, Parker, Webb, and Wise. These were the same as in 1906. Lignite was produced in 9 counties, Bastrop, Fayette, Hopkins, Houston, Leon, Medina, Milam, Robertson, and Wood. Of these 9, Fayette, Leon, and Robertson did not produce in 1906.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables. Owing to the fact that there are only one or two mines in each county, the production of the bituminous and the lignite producing counties, respectively, is combined.

*Coal production of Texas in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Bituminous: | | | | | | | | |
| Erath | 799,974 | 18,428 | 21,583 | 839,985 | $1,779,890 | $2.12 | 233 | 2,333 |
| McCullough | | | | | | | | |
| Maverick | | | | | | | | |
| Palo Pinto | | | | | | | | |
| Parker | | | | | | | | |
| Webb | | | | | | | | |
| Wise | | | | | | | | |
| Lignite: | | | | | | | | |
| Bastrop | 464,244 | 3,958 | 4,686 | 472,888 | 399,011 | .84 | 210 | 715 |
| Hopkins | | | | | | | | |
| Houston | | | | | | | | |
| Medina | | | | | | | | |
| Milam | | | | | | | | |
| Wood | | | | | | | | |
| Total | 1,264,218 | 22,386 | 26,269 | 1,312,873 | 2,178,901 | 1.66 | 227 | 3,048 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|
| Bituminous: | | | | | | | | |
| Erath | 906,181 | 7,348 | 26,808 | 940,337 | $2,062,918 | $2.19 | 255 | 3,137 |
| McCullough | | | | | | | | |
| Maverick | | | | | | | | |
| Palo Pinto | | | | | | | | |
| Parker | | | | | | | | |
| Webb | | | | | | | | |
| Wise | | | | | | | | |
| Lignite: | | | | | | | | |
| Bastrop | 678,395 | 19,770 | 9,567 | 707,732 | 715,893 | 1.01 | 204 | 1,090 |
| Fayette | | | | | | | | |
| Hopkins | | | | | | | | |
| Houston | | | | | | | | |
| Leon | | | | | | | | |
| Medina | | | | | | | | |
| Milam | | | | | | | | |
| Robertson | | | | | | | | |
| Wood | | | | | | | | |
| Total | 1,584,576 | 27,118 | 36,375 | 1,648,069 | 2,778,811 | 1.69 | 242 | 4,227 |

The coals of Texas occur in three coal-bearing formations—the Tertiary, the Cretaceous, and the Carboniferous. In the north-central portion of the State are found the bituminous coals, in what is known as the Southwestern field. It is about 250 miles in length, with an average width of about 45 miles, and contains approximately 11,000 square miles. The known coal-bearing strata are, however, much more limited, being confined to the central part of the entire field. The principal mining operations are in Wise, Palo Pinto, Erath, and McCullough counties. Small quantities have been mined in Eastland, Coleman, and Bowie counties, but no production was reported from these counties in 1906 or 1907. The coals of the Cretaceous formation occur in the southern portion of the State, and mining operations are carried on at Eagle Pass, in Maverick County. Lignite beds of Tertiary age extend entirely across the State from the eastern boundary at Sabine River in a southwesterly direction to the Rio Grande. In the southwestern extremity, near Laredo, in Webb County, the lignite approaches bituminous in character, and the Webb County production is classed as bituminous. Lignite mining operations have been carried on in Anderson, Bastrop, Fayette, Hopkins, Houston, Leon, Medina, Milam, Raines, Robertson, Shelby, and Wood counties, the principal operations being in Medina, Milam, and Wood. During the last few years, or since the discoveries of oil at Beaumont, the lignite-producing industry has suffered greatly from the use of fuel oil, with which it comes into direct competition. Decided advances in the price of fuel oil in 1907, however, reacted favorably upon the demand for and production of lignite, resulting in the largest output and the highest prices ever recorded.

The Tenth United States Census for 1880 did not report any coal production in Texas, the first recorded production being for 1884 and published in Mineral Resources of the United States. The production reported for that year was 125,000 short tons. The growth of the industry since that date is shown in the table on a preceding page, which gives the production of coal in the United States from the earliest times to the close of 1907.

Mr. Campbell's estimates of the coal areas of Texas place the bituminous fields as known to contain workable coal at 8,200 square miles, with 5,300 square miles of area not so well known, but which may contain workable coal. The known lignite areas cover 2,000 square miles, while there are 53,000 square miles, extending from the Sabine and the Red rivers on the east and north to the Rio Grande on the southwest, which may contain workable beds of lignite. The estimated original supply of bituminous coal in Texas is placed at 8,000,000,000 short tons, and of lignite at 23,000,000,000 tons, making a total of 31,000,000,000 tons as the original supply. From this there had been produced to the close of 1907 a total of 14,444,948 short tons, which represents an exhaustion of approximately 22,000,000 tons, the exhaustion representing .07 of 1 per cent of the original supply. The supply left in the ground at the close of 1907 would be equal to 19,000 times the production of that year.

## UTAH.

Total production in 1907, 1,947,607 short tons; spot value, $2,959,769.

Although the monetary disturbances in the last 3 months of 1907 affected the coal-mining industry in Utah to a considerable extent, the record made during the first 9 months of the year was sufficient to more than overcome the effects of the depression so far as the production in 1907 compared with preceding years. During 1906, which up to that time had been the most prosperous in the coal-mining industry of the State, the production of coal amounted to 1,772,551 short tons, valued at $2,408,381. Compared with these figures, the increase in quantity in 1907 amounted to 175,056 short tons, or 9.88 per cent, and the increase in value to $551,388, or 22.89 per cent. These statistics indicate that until the effects of the panic in the latter part of the year began to be felt the demand for Utah coal had been somewhat in excess of the supply, with the higher prices which naturally accompany such a condition. Nor was this the only way in which the business was satisfactory to the operators during the year. The product of the mines was handled by the railroad companies in a satisfactory manner and complaints of shortage of car supply were insignificant.

The effects of the panic were felt in some of the Rocky Mountain States, and particularly in Utah, more severely than in some of the more easterly States. With the first gusts of the financial storm came the closing down of the copper mines and smelters in Montana, and immediately following this, and the falling off in the demand for coke, the ovens at Castle Gate, Utah, were put out of blast. This was soon followed by the closing of a number of metal mines and smelters in Utah, and resulted in the shutting down of several of the larger coal mines in the State. At the end of the year the outlook for the coal and coke trade in Carbon County, which is the principal producing county in the State, was anything but promising. In addition to the fact that some of the mines were shut down entirely and others were worked on half or even less time, as a result of the closing down of the smelters in Montana and Utah, exceptionally mild weather lessened the demand for coal for domestic purposes.

The coal mines of Utah gave employment in 1907 to 2,203 men who worked an average of 258 days, against 1,572 men for an average of 288 days in 1906. The record for 1907 shows a distinct falling off in the average efficiency of the mine workers, the average production per man having decreased from 1,127.6 tons in 1906 to 884 tons in 1907. In 1905 Utah's average production per man was 979. The average daily production per man in Utah during 1907 was 3.43 tons, against 3.92 tons in 1906 and 3.96 tons in 1905.

There have been few labor disturbances of any kind in the coal mines of Utah during the last 3 years. In 1907 there was only 1 strike, and this one, which affected 148 men, lasted but 4 days. There were practically no labor disturbances in 1905 and 1906.

Mr. J. E. Pettit, who has succeeded Mr. Gomer Thomas as State mine inspector, reports that in 1907 there were 6 fatal and 82 nonfatal accidents in the coal mines of Utah. Of the nonfatal accidents, 6 were of a serious character. Of the 6 fatal accidents, 3 were due to falls of roof or coal, 1 to an explosion, and 2 were due to other causes. Of the men injured, 26 were hurt by falls of roof or coal, 4 by gas or dust explosions, and 52 from other causes. The death rate per thousand employees was 2.72 in 1907, against 4.45 in 1906. The number of tons mined for each life lost was 324,601 in 1907, against 253,222 in 1906.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Utah in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | |
| Carbon | 1,082,660 | 5,778 | 52,235 | 552,408 | 1,693,081 | $2,291,171 | $1.35 | 295 | 1,420 |
| Emery | | 4,954 | | | 4,954 | 7,356 | 1.48 | 169 | 30 |
| Morgan<br>Sanpete | 3,112 | 3,137 | 20 | | 6,269 | 14,233 | 2.27 | 190 | 25 |
| Summit<br>Uinta | 56,355 | 5,931 | 4,757 | | 67,043 | 94,232 | 1.41 | 266 | 97 |
| Small mines | | 1,204 | | | 1,204 | 1,389 | 1.15 | | |
| Total | 1,142,127 | 21,004 | 57,012 | 552,408 | 1,772,551 | 2,408,381 | 1.36 | 288 | 1,572 |
| **1907.** | | | | | | | | | |
| Carbon | 1,199,145 | 6,217 | 58,636 | 572,441 | 1,836,439 | $2,729,664 | $1.49 | 267 | 2,010 |
| Emery | 200 | 4,847 | 5 | | 5,052 | 8,371 | 1.66 | 107 | 22 |
| Morgan<br>Sanpete | 1,963 | 1,773 | | | 3,736 | 9,637 | 2.58 | 123 | 18 |
| Summit<br>Uinta | 86,341 | 8,957 | 6,727 | | 102,025 | 211,519 | 2.07 | 174 | 153 |
| Small mines | | 355 | | | 355 | 578 | 1.63 | | |
| Total | 1,287,649 | 22,149 | 65,368 | 572,441 | 1,947,607 | 2,959,769 | 1.52 | 258 | 2,203 |

The statistics of production, by counties, for the last 5 years with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Utah, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Carbon | 1,599,986 | 1,416,623 | 1,258,346 | 1,693,081 | 1,836,439 | + 143,358 |
| Emery | 8,178 | 4,031 | 3,692 | 4,954 | 5,052 | + 98 |
| Morgan<br>Sanpete | 7,296 | 7,733 | 6,136 | 6,269 | 3,736 | − 2,533 |
| Summit<br>Uinta | 64,054 | 61,320 | 61,966 | 67,043 | 102,025 | + 34,982 |
| Small mines | 1,895 | 3,320 | 2,232 | 1,204 | 355 | − 849 |
| Total | 1,681,409 | 1,493,027 | 1,332,372 | 1,772,551 | 1,947,607 | + 175,056 |
| Total value | $2,026,038 | $1,943,440 | $1,793,510 | $2,408,381 | $2,959,769 | +$551,388 |

The coal fields of Utah are important and widely distributed. They may be grouped geographically as follows: The Book Cliffs, Wasatch, Weber River, Southern Utah, and small scattered fields.

The Book Cliffs field, including its southern extension, the Wasatch field, is the largest and most important in the State. The coal-bearing rocks of this field underlie many thousand square miles of the Uinta Basin and outcrop along its southern margin in the Book Cliffs of western Colorado and eastern Utah. There are several beds of coal in this field varying from 3 to 20 feet in thickness, which occur in the lower part of the Mesaverde formation of upper Cretaceous age. The lowland at the base of the Book Cliffs is traversed by the Rio

Grande Western Railroad, and all of the large mines in the State are situated in this field. The most important mines are those at Sunnyside, Castlegate, Winter Quarters, and Clear Creek, which produce 95 per cent of the coal output of the State. The coal is medium grade, bituminous and locally produces a good quality of coke, over 570,000 tons of the total coal production of 1907 being consumed in the manufacture of coke. The Weber River field, in the northern part of the State, at present is next in importance. It has an area of only a few square miles but is reached by a branch of the Union Pacific Railroad. Two beds, varying from 7 to 14 feet in thickness, are mined at Coalville. Difficulties in the way of large exploitation are caused by water and extensive fracturing of the rocks. The Weber River coal is of Colorado age—upper Cretaceous.

The other coal fields of Utah, with the exception of a small area in Sanpete County, where a thin bed of coal is mined at Sterling on the Sanpete Valley Railroad, are far from railroads and are practically undeveloped. The largest of these is the Southern Utah field. There the outcrop of coal-bearing rocks can be traced for many miles in the Colob plateau and its eastern extension in Iron, Washington, Kane, and Garfield counties. The coal is of Colorado age and varies in thickness from less than 1 foot to more than 10 feet. It has been opened at only a few places near the towns of Cedar City, Kanarra, Upper Kanab, and Escalante. So far as known, the coal is chiefly low-grade bituminous, but locally coal of better quality has been found. A fair grade of cannel coal occurs in the North Fork of Virgin River in the northwestern corner of Kane County, and a small area of semianthracite coal has long been known a few miles north of the town of New Harmony, in Iron County. It is probable that the western part of this field will soon be tapped by a branch of the San Pedro, Los Angeles and Salt Lake Railroad.

Near Vernal, in Uinta County, there is a small area of workable coal of Colorado age. Other scattering fields are known in the southeastern part of the State, but they are so far removed from railroads that at present they are of little importance.

The areas in Utah known to contain workable beds of coal aggregate 13,130 square miles, while there are 2,000 square miles less known but which may contain workable coals. The estimated original contents of these fields, according to Mr. M. R. Campbell, of the United States Geological Survey, are placed at 196,458,000,000 short tons. The production of the State since mining began, about 1870, has amounted to 18,837,182 short tons, of which 1,947,607 short tons, or a little over 10 per cent, were mined in 1907. Upon the basis of for every 2 tons mined 1 ton of coal is lost, the exhaustion of the Utah fields to the close of 1907 is approximately 28,000,000 short tons, or .014 of 1 per cent of the estimated original supply.

## VIRGINIA.

Total production in 1907, 4,710,895 short tons; spot value, $4,807,533.

In 1906 Virginia was the only one of the important coal-producing States east of the Mississippi River whose production was less than that of the preceding year. The decrease was, however, unimportant, amounting to 20,392 short tons, or one-half of 1 per cent. In

1907 Virginia was counted among the twenty-nine States which contributed to the large increased production over 1906. Virginia's production increased from 4,254,879 tons to 4,710,895 tons, a gain of 456,016 tons, or 10.72 per cent, with an increase in value of $623,542, or 14.9 per cent, from $4,183,991 to $4,807,533. For the first time in recent years the average price per ton for coal produced in Virginia exceeded $1.

The mining of coal in southwestern Virginia, whence the present production chiefly comes, began with the completion of the New River division of the Norfolk and Western Railroad in 1883, in which year the first carload of coal was shipped to Norfolk and distributed among the poor. During the next 10 years nearly the entire production of the State was obtained from this locality in Tazewell County, which forms a part of the famous Pocahontas-Flat Top coal field. Ten years from the opening of this district, or in 1892, the extension of the Clinch Valley branch of the Norfolk and Western Railroad made accessible rich coal fields in Wise County, the first production in that county having been reported in 1893, when it amounted to 126,216 tons, while that of Tazewell County was 653,374 tons. In 1897 the Wise County production exceeded that of Tazewell County and since that date Wise County has rapidly forged to the front as the principal coal-producing county of the State, having in 1907 had nearly three times the output of Tazewell County. The year 1907, practically 15 years from the opening of the Wise County field, and 25 years from the development of the Pocahontas district, marked the beginning of coal mining in another county in Virginia which promises to show a development rivaling the rapid growth of Wise County. Lee County, in which is located the Black Mountain coal field, showed for 1907 a production of 198,913 tons, and as stated in the report for 1906, this promises to prove an important coal-producing center. In addition, a considerable amount of development work has been done in Dickenson and Buchanan counties, which have been made accessible by the construction of the South and Western Railroad now building from Elkhorn, Pike County, Ky., to Spartanburg, S. C. The Lee County properties have been made available through the completion of the Virginia and Southwestern Railroad, making connection with the Louisville and Nashville Railroad at Appalachia and Pennington Gap and with the Southern Railway and Norfolk and Western Railroad at Bristol. The Virginia and Southwestern has passed into the control of the Southern Railway.

Although the coal fields of southwestern Virginia are of comparatively limited extent, the high quality of the coal and the number and thickness of the beds give promise of a considerably increased production within the next few years.

In 1907 there were employed in the coal mines of Virginia 6,670 men, who worked an average of 241 days, against 5,131 men for 250 days in 1906. The average production per man decreased from 829.2 tons in 1906 to 706 tons in 1907, while the average daily production decreased from 3.32 to 2.93 tons. This apparent falling off in efficiency was due to the large number of men employed in the development work previously referred to. The larger number of miners in Virginia are unorganized and the coal-mining operations are conducted on the basis of a 10-hour day. In 1907, 42 mines, employing 5,791 men, worked 10 hours a day, and 7 mines, employing 849 men, worked 9 hours.

The number of mining machines in use in the coal mines of Virginia increased from 35 in 1905 to 37 in 1906 and to 77 in 1907, while the machine-mined product increased from 399,029 short tons in 1905 to 424,343 tons in 1906 and 788,793 tons in 1907. The increase in machine-mined coal in 1907 over 1906 was 364,450 short tons, or nearly 80 per cent of the total increase in the coal production of the State.

There were no labor disturbances of any kind in the coal mines of Virginia during the last four years, as far as reported.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Virginia in 1906 and 1907, by counties, in short tons.*

1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Tazewell | 687,958 | 10,441 | 17,126 | 195,113 | 910,638 | $931,517 | $1.03 | 241 | 1,098 |
| Wise | 971,959 | 29,329 | 62,636 | 1,977,301 | 3,041,225 | 2,915,914 | .95 | 260 | 3,382 |
| Other counties[a] and small mines | 280,607 | 10,505 | 11,904 | .......... | 303,016 | 336,560 | 1.11 | 210 | 651 |
| Total | 1,940,524 | 50,275 | 91,666 | 2,172,414 | 4,254,879 | 4,183,991 | .98 | 250 | 5,131 |

1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Lee | 179,916 | 17,545 | 1,452 | .......... | 198,913 | $228,888 | $1.15 | 199 | 432 |
| Tazewell | 866,259 | 17,256 | 19,575 | 213,444 | 1,116,534 | 1,240,747 | 1.11 | 206 | 1,580 |
| Wise | 1,079,280 | 36,395 | 67,883 | 1,962,288 | 3,145,846 | 3,066,075 | .97 | 262 | 3,846 |
| Other counties[b] and small mines | 234,351 | 7,508 | 7,743 | .......... | 249,602 | 271,823 | 1.09 | 232 | 812 |
| Total | 2,359,806 | 78,704 | 96,653 | 2,175,732 | 4,710,895 | 4,807,533 | 1.02 | 241 | 6,670 |

[a] Lee, Montgomery, Pulaski, and Russell.

[b] Montgomery, Pulaski, and Russell.

The statistics of production, by counties, during the last 5 years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Virginia, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Montgomery | 20,288 | .......... | .......... | .......... | .......... | .......... |
| Tazewell | 840,195 | 871,720 | 961,380 | 910,638 | 1,116,534 | + 205,896 |
| Wise | 2,563,285 | 2,359,661 | 2,990,698 | 3,041,225 | 3,145,846 | + 104,621 |
| Chesterfield | 18,084 | 2,100 | .......... | .......... | .......... | .......... |
| Henrico |  |  |  |  |  |  |
| Pulaski | 9,255 | [a] 177,133 | [b] 323,073 | [b] 302,896 | [b] 448,515 | + 145,619 |
| Russell |  |  |  |  |  |  |
| Small mines | 200 | 300 | 120 | 120 | .......... | − 120 |
| Total | 3,451,307 | 3,410,914 | 4,275,271 | 4,254,879 | 4,710,895 | + 456,016 |
| Total value | $3,302,149 | $2,921,911 | $3,777,325 | $4,183,931 | $4,807,533 | +$623,542 |

[a] Includes Montgomery County.

[b] Includes Lee and Montgomery counties.

The first bituminous coal mined in the United States was taken from what is usually termed the Richmond basin, a small area of Triassic age in the southeastern portion of the State, near the city of Richmond. This basin is situated on the eastern margin of the Piedmont Plateau, 13 miles above tide, on the James River. It lies in Goochland, Henrico, Powhatan, and Chesterfield counties. The coal beds are much distorted, and the coal is of rather low grade when compared with that from other districts with which it has to come into competition. The mines are also gaseous, and since the coals from the New River district, in West Virginia, and other high-grade coals from other sources have been brought to the markets formerly supplied by coal from the Richmond basin the production has fallen off rapidly, until at the present time only a small quantity is occasionally mined there for purely local consumption. No production was reported from this district in 1907.

The occurrence of coal was known in the Richmond basin as early as 1700, and it was used in the latter quarter of the eighteenth century. In 1789 shipments were made to some of the Northern States. In 1822, according to Mr. R. C. Taylor, the production amounted to 48,214 long or 54,000 short tons. During the latter part of the nineteenth century expensive, but unsuccessful, efforts were made to reestablish the industry in this field. The coal, however, could not be forced upon the market in competition with the higher-grade coals from other districts, and at the present time what little coal is produced there is for local consumption only. With the completion of the Norfolk and Western Railroad, in 1882, the coal fields in the southwestern part of the State, which belong to the Appalachian system, were opened up. A portion of the famous Pocahontas district is included within the county of Tazewell, in Virginia, and the construction of the Clinch Valley branch of the Norfolk and Western Railroad, in 1892, opened up valuable coal lands in Wise County, which has since become the most important producing district in the State. Development of what promises to be a formidable rival of the Tazewell and Wise County districts was begun in Lee County in 1905 and has already been referred to. This new district is chiefly contained in what is known as Black Mountain, a portion of the Cumberland range. No less than twelve separate coal beds of workable thickness have been located, and mining operations on several of them have been started. Most of the coal is of high-grade steam and coking quality.

Two small outlying basins from the Appalachian fields are found in the State—one in Frederick County, at the north, and the other in Pulaski and Montgomery counties, at the south. In both the coal is of a semianthracite character, but the only developments on a practical scale have been made in the Pulaski-Montgomery basin. During the last three or four years a large amount of work in opening up has been done in Montgomery County by the Virginia Anthracite Coal Company, and it appears probable that the county will become one of the important producers. Previous to 1904 all of the coal mined was from comparatively small mines, the product being consumed in the immediate vicinity.

## WASHINGTON.

Total production in 1907, 3,680,532 short tons; spot value, $7,679,801.

Although a good part of the market for Washington coal in California has been lost through the increased production of fuel oil in that State, Washington shared in the general increase in the production of coal in 1907. During the first ten months of the year the coal-mining industry of the State was in a highly satisfactory condition. In November and December, however, owing to the financial disturbances, the output of the mines is estimated to have been curtailed about 33 per cent. Except for this the production would probably have exceeded 4,000,000 tons. During the summer a campaign of education had been kept up with the idea of inducing the consumers to lay in their supplies of coal during the summer and avoid the shortage of coal which had been experienced in the previous winter. Domestic consumers followed this advice and stored a liberal supply at comparatively high prices during the summer. The anticipations of a winter similar to the preceding one were not realized.

Compared with 1906 the coal production of Washington in 1907 exhibited an increase of 404,348 short tons, or 12.34 per cent in quantity, and of $1,771,367, or 29.98 per cent, in value. The average price per ton advanced from $1.80 in 1906 to $2.09 in 1907.

The number of men employed in the coal mines of Washington increased from 4,529 in 1906 to 5,945 in 1907, and the average number of working days increased from 266 to 273. The only decrease shown in the statistics of coal production in Washington in 1907 as compared with 1906 was in the productive capacity of the employees, the average yearly tonnage per man having declined from 723.4 tons in 1906 to 619 tons in 1907. The average daily production per man decreased from 2.72 to 2.27.

Nearly all of the mines of the State are operated on an 8-hour per day schedule, there being 5,594 men out of a total of 5,945 employed who worked 8 hours a day in 1907.

There are 16 plants in the State in which washing apparatus has been installed. These have a total of 40 jigs or washeries, and the total amount of coal washed during 1907 was 799,015 short tons, yielding 644,501 tons of cleaned coal and 154,514 tons of refuse.

Mr. D. C. Botting, State mine inspector, reports that the total number of accidents in the coal mines of Washington in 1907 was 131, of which 36 were fatal and 95 nonfatal. Of the total number of deaths, 10 were due to explosions of gas or dust, 8 to falls of roof or coal, 3 to coming into contact with electric wires, 4 to being crushed by cars, 3 to cave-ins, and 4 to suffocation by white damp. Four deaths, due to miscellaneous causes, occurred singly. Of the 95 nonfatal accidents, 25 men were injured by cars, 32 by falls of roof or coal, 20 received injuries through gas explosions, and 18 injuries were due to miscellaneous causes. The death rate per thousand of employees was 6.06, and the number of tons mined for each life lost was 102,237. This makes an unfavorable comparison with the casualty statistics for 1906, and particularly with 1905. In 1906 the death rate per thousand of employees was 4.86 and the tonnage for each life lost was 148,917, while in 1905 the death rate per thousand was 2.73, with a tonnage of 220,379 for each life lost.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of Washington in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | |
| King | 1,219,047 | 37,331 | 54,152 | ........ | 1,310,530 | $2,148,055 | $1.64 | 273 | 1,726 |
| Kittitas | 1,376,771 | 18,372 | 27,469 | ........ | 1,422,612 | 2,603,624 | 1.83 | 265 | 1,742 |
| Lewis | 23,693 | 275 | 1,912 | ........ | 25,880 | 61,382 | 2.37 | 188 | 70 |
| Pierce | 385,857 | 4,669 | 26,892 | 96,221 | 513,639 | 1,086,145 | 2.11 | 263 | 980 |
| Other counties[a] | 2,780 | 499 | 244 | ........ | 3,523 | 9,228 | 2.62 | 157 | 11 |
| Total | 3,008,148 | 61,146 | 110,669 | 96,221 | 3,276,184 | 5,908,434 | 1.80 | 266 | 4,529 |
| **1907.** | | | | | | | | | |
| King | 1,325,054 | 55,470 | 61,189 | 3,920 | 1,445,633 | $2,799,747 | $1.94 | 283 | 2,166 |
| Kittitas | 1,467,055 | 22,571 | 35,261 | ........ | 1,524,887 | 3,159,501 | 2.07 | 284 | 2,380 |
| Lewis | 91,985 | 6,344 | 5,210 | ........ | 103,539 | 260,262 | 2.51 | 237 | 191 |
| Pierce | 451,833 | 4,821 | 29,027 | 86,488 | 572,169 | 1,380,010 | 2.41 | 248 | 1,099 |
| Other counties[b] | 29,170 | 1,556 | 3,578 | ........ | 34,304 | 80,281 | 2.34 | 161 | 109 |
| Total | 3,365,097 | 90,762 | 134,265 | 90,408 | 3,680,532 | 7,679,801 | 2.09 | 273 | 5,945 |

[a] Cowlitz and Whatcom.

[b] Cowlitz, Thurston, and Whatcom.

The statistics of production, by counties, for the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Production of coal in Washington, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase(+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Cowlitz | ........ | 1,800 | [a] 3,706 | [a] 3,523 | [a] 7,424 | + 3,901 |
| King | 1,229,560 | 1,219,230 | 1,099,163 | 1,310,530 | 1,445,633 | + 135,103 |
| Kittitas | 1,369,716 | 1,340,400 | 1,280,845 | 1,422,612 | 1,524,887 | + 102,275 |
| Lewis | 1,410 | 1,335 | 1,300 | 25,880 | 103,539 | + 77,659 |
| Pierce | 572,800 | 531,589 | 479,912 | 513,639 | 572,169 | + 58,530 |
| Skagit | 19,115 | 10,650 | ........ | ........ | ........ | ........ |
| Whatcom | 672 | 1,837 | ........ | ........ | ........ | ........ |
| Other counties | ........ | 30,840 | ........ | ........ | 26,880 | + 26,880 |
| Total | 3,193,273 | 3,137,681 | 2,864,926 | 3,276,184 | 3,680,532 | + 404,348 |
| Total value | $5,380,679 | $5,120,931 | $5,141,258 | $5,908,434 | $7,679,801 | +$1,771,367 |

[a] Includes Whatcom County.

The coal fields of Washington are confined to the western and central portions of the State. Five principal fields may be mentioned—the North Puget Sound field, including the coal mines of Skagit and Whatcom counties; the South Puget Sound field, containing the operations in King and Pierce counties; the Puget Sound basin, just east of Seattle; the Roslyn field, in Kittitas County, on the eastern slope of the Cascade Mountains, and the southwestern field, embracing the counties of Lewis and Cowlitz.

The coals of Washington range from lignite to bituminous coking coals, and some natural coke and anthracite have been observed. The bituminous coking coals of Washington are the only coking coals on the Pacific slope of the United States. The coking coals are found in the Wilkeson-Carbonado district, in the South Puget Sound field, and in the North Puget Sound field, but at present coke is made only in the first-named district. The Wilkeson-Carbonado coal runs high in ash and is usually washed before coking. The lignite or subbituminous coals of Newcastle and Renton, in the South Puget Sound field, are generally of high grade and well suited for domestic use. The steamship consumption in trade with Alaska and the Orient is now the most important market for the high-grade bituminous coals of Washington.

Coal was first discovered in Washington in 1848, when a lignite of rather low grade was found in the Cowlitz Valley. Four years later bituminous coal was discovered on Bellingham Bay, Whatcom County, and the first mine in the State was opened on this bed. Shipments did not begin, however, until 1860. This mine was operated continuously from 1860 until 1878, when, on account of a fire caused by spontaneous combustion, the workings were abandoned. and they have not since been reopened. Shipments were not resumed from any of the mines in the northern district until 13 years later—1891. Coal was discovered in King County in 1859, and mining began near the present Issaquah in 1862. Shipments to San Francisco began in 1871, since which time the Washington mines have been an important source of coal supply to the San Franicsco market. About the same time the Talbot and Renton mines, which are in King County, began shipping, and rail connection between the Renton mines and Seattle was obtained in 1877. Production in the Green River field, also in King County, began between 1880 and 1885; and the Pierce County fields, which had been opened up in 1875 and afterwards abandoned, again began shipping about the same time. The Roslyn mines, on the east side of the Cascade Range, were opened in the first half of the same decade. The Bellingham Bay mines in the first year of their recorded production, 1860, shipped 5,374 tons. In 1907 Washington's output of coal was 3,680,532 short tons.

The United States census report for 1860 contains the first record of coal production in Washington. This production was entirely from the Bellingham Bay properties, in Whatcom County, and amounted to 5,374 short tons. The State did not assume much importance as a coal producer, however, until the opening of the Green River field, in King County, between 1880 and 1885, and of the Roslyn mines, in Kittitas County, which began producing about the same time. The growth of the industry since 1860, when production began, is shown in the table on a preceding page, giving the statistics of coal production in the United States from the earliest times to the close of 1907.

The production of coal in Washington from the time when coal mining first began, in 1860, has amounted to 43,108,697 tons, representing an exhaustion of approximately 64,000,000 tons. Mr. Campbell estimates the original coal supply of the State of Washington as 20,000,000,000 short tons, of which the exhaustion to the close of 1907 represented one-third of 1 per cent. According to these estimates, the quantity of coal still in the ground at the close of 1907 was 19,936,000,000—5,400 times the production of 1907 and 3,600 times the exhaustion represented by that output.

## WEST VIRGINIA.

Total production in 1907, 48,091,583 short tons; spot value, $47,846,630.

West Virginia's triumph over Illinois was of short duration. In 1906, as a result of the suspension of from 2 months to 10 weeks at the majority of the Illinois mines, pending an adjustment of the wage scale, the coal production of Illinois was materially restricted, whereas in West Virginia, where the miners are for the most part unorganized, operations were carried on practically without interruption, and that State outranked Illinois, with a lead of 1,810,246 short tons. The record for 1907, however, showed that the production of Illinois made a phenomenal increase of 9,837,042 short tons, more than double West Virginia's increase of 4,801,233 short tons, and West Virginia again dropped to third place in rank among the coal-producing States. Compared with 1906, West Virginia's coal production in 1907 showed an increase of 4,801,233 short tons, or 11.09 per cent in quantity, and of $6,794,691, or 16.55 per cent in value. During the first nine months of the year business was exceptionally active and the demand for coal was considerably in excess of the cars to transport it, but West Virginia being one of the producers of high-grade steaming and coking coals, the influence of the monetary disturbances of October was keenly felt. Coke making fell off quickly as soon as the panic began, and the coal production of the State during the last ten weeks of the year was probably not more than 50 per cent of the capacity. Had the production kept up for the entire year at the rate exhibited during the first nine months the total production would probably have reached 53,000,000 short tons.

It may not be out of place at this point to call attention to the peculiar conditions under which coal-mining operations in West Virginia are carried on. In one respect it differs from any of the other important coal-producing States, in that except for the product which goes into railroad consumption, a comparatively small amount used for manufacturing purposes, and that which is used for purely domestic consumption, practically all of the product is shipped outside of the State for consumption. When compared with the production of coal in the State, the manufacturing industries of West Virginia fall into insignificance. The bituminous coal production of Pennsylvania, Ohio, Indiana, Illinois, Alabama, and the other important coal-producing States goes largely into the maintenance of manufacturing industries, which add to the wealth of a State and build up the most desirable communities, whereas the greater part of the coal mined in West Virginia is sent out of the State to assist manufacturing communities elsewhere. The question may well be asked, is it not time for West Virginia to develop a Pittsburg, a Chicago, or a St. Louis within its borders?

The total number of men employed in the coal mines of West Virginia in 1907 was 59,029, who worked an average of 230 days, against 50,960 men for an average of 220 days in 1906, and 48,389 men for an average of 209 days in 1905. The average production per year per man in 1907 was 815, against 849.5 tons in 1906 and 781 tons in 1905. The average daily production per man was 3.54 against 3.86 tons in 1906 and 3.74 tons in 1905. The decline in the productive efficiency per man employed was in spite of the fact that the production by the use of machines increased from 15,565,113 tons in 1906 to 17,627,925 tons in 1907, and the percentage of the machine-mined product increased from 36 to 36.65. In 1906 there were 1,322 machines in use, and in 1907, 1,533. Of the total number of machines in use in 1907, 617 were of the pick or puncher type, 853 were chain-breast machines, and 63 were long wall.

The somewhat vigorous attempts which have been made from time to time to organize the coal miners of West Virginia have been only partially successful, and the majority of the mines continue to be operated either on the "open shop" or nonunion basis.

The majority of the miners worked either 9 or 10 hours a day. In 1907 there were 322 mines, employing 32,005 men, which worked 10 hours a day, and 156 mines, employing 13,386 men, which worked 9 hours. There were 35 mines, employing 1,879 men, which worked 8 hours, and 11,759 men whose time was not reported.

The time lost by strikes in West Virginia both in 1906 and 1907 was unimportant. In 1907 there were 617 men idle on account of strikes for an average of 16 days each.

On account of the terrible disaster at the Monongah mines of the Fairmont Coal Company in December, 1907, the casualty record for the year gave West Virginia the highest death rate per thousand and the lowest tonnage for each life lost of any of the coal-producing States. According to the statistics compiled by Mr. J. W. Paul, chief, Department of Mines, the total number of men killed in the coal mines of West Virginia in 1907 was 729, of which 484 were killed as a result of gas or dust explosions, most of them in the disaster at Monongah. As showing the completeness with which such disasters are attended with fatal results, while 484 men were reported as killed by gas or dust explosions, none was reported as injured by this cause. Falls of roof or coal were responsible for 144 deaths and 104 injuries, and powder explosions and windy shots were responsible for 23 deaths and 34 injuries, while 78 deaths and 107 injuries were attributed to miscellaneous causes. The death rate per thousand of employees was 12.35, and the number of tons mined for each life lost was 65,969.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following tables:

*Coal production of West Virginia, in 1906 and 1907, by counties, in short tons.*

### 1906.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Barbour | 766,075 | 4,500 | 15,159 | 207,947 | 993,681 | $892,442 | $0.90 | 245 | 962 |
| Brooke | 457,476 | 22,730 | 3,050 | .......... | 483,256 | 490,040 | 1.01 | 218 | 600 |
| Clay | 76,462 | 2,260 | 663 | .......... | 79,385 | 83,308 | 1.05 | 179 | 101 |
| Fayette | 7,037,196 | 86,162 | 136,382 | 1,000,567 | 8,260,307 | 8,242,522 | 1.00 | 205 | 10,992 |
| Grant | 282,112 | 2,593 | 12,321 | .......... | 297,026 | 292,273 | .98 | 273 | 304 |
| Harrison | 3,569,339 | 13,184 | 32,432 | 11,382 | 3,626,337 | 3,134,680 | .86 | 231 | 3,251 |
| Kanawha | 4,756,445 | 62,417 | 59,945 | 1,500 | 4,880,307 | 4,851,113 | .99 | 202 | 6,891 |
| Logan | 576,443 | 8,211 | 8,241 | .......... | 592,895 | 576,972 | .97 | 170 | 825 |
| McDowell | 6,002,513 | 71,353 | 105,218 | 2,528,593 | 8,707,677 | 8,259,449 | .95 | 214 | 9,901 |
| Marion | 3,746,007 | 21,407 | 58,405 | 337,643 | 4,163,462 | 3,621,219 | .87 | 245 | 3,216 |
| Marshall | 412,878 | 89,526 | 8,931 | .......... | 511,335 | 495,489 | .97 | 219 | 644 |
| Mason | 72,286 | 37,375 | 2,999 | .......... | 112,660 | 109,264 | .97 | 204 | 269 |
| Mercer | 1,651,501 | 16,134 | 27,676 | 504,519 | 2,199,830 | 2,039,501 | .93 | 238 | 2,161 |
| Mineral | 656,386 | 4,250 | 1,302 | .......... | 661,938 | 664,334 | 1.00 | 234 | 698 |
| Mingo | 2,141,070 | 46,776 | 22,430 | .......... | 2,210,276 | 2,008,922 | .91 | 246 | 2,418 |
| Monongalia | 136,668 | 9,965 | 8,272 | 173,503 | 328,408 | 286,837 | .87 | 228 | 382 |
| Nicholas | 72,100 | 5,360 | 2,175 | .......... | 79,635 | 92,755 | 1.16 | 192 | 194 |
| Ohio | 93,909 | 26,472 | 1,083 | .......... | 121,464 | 125,014 | 1.03 | 146 | 239 |
| Preston | 773,940 | 12,095 | 30,544 | 312,765 | 1,129,344 | 936,635 | .83 | 255 | 1,578 |
| Putnam | 540,523 | 3,330 | 4,872 | .......... | 548,725 | 580,347 | 1.06 | 239 | 988 |
| Raleigh | 1,077,827 | 14,878 | 12,613 | .......... | 1,105,318 | 1,164,133 | 1.05 | 226 | 1,923 |
| Randolph | 246,220 | 8,244 | 4,739 | 128,559 | 387,762 | 347,539 | .89 | 241 | 415 |
| Taylor | 432,995 | 9,348 | 3,084 | .......... | 445,427 | 360,489 | .81 | 195 | 441 |
| Tucker | 686,740 | 16,973 | 24,770 | 470,558 | 1,199,041 | 1,234,030 | 1.03 | 209 | 1,235 |
| Other counties[a] and small mines | 124,372 | 37,944 | 2,538 | .......... | 164,854 | 162,614 | .99 | 188 | 272 |
| Total | 36,389,483 | 633,487 | 589,844 | 5,677,536 | 43,290,350 | 41,051,939 | .95 | 220 | 50,960 |

### 1907.

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| Barbour | 894,127 | 5,160 | 19,987 | 256,489 | 1,175,763 | $1,010,824 | $0.86 | 250 | 1,133 |
| Brooke | 435,579 | 16,540 | 2,000 | .......... | 454,119 | 462,763 | 1.02 | 203 | 628 |
| Clay | 62,232 | 599 | 916 | .......... | 63,747 | 64,612 | 1.01 | 172 | 111 |
| Fayette | 7,128,491 | 178,207 | 167,714 | 1,125,566 | 8,599,978 | 9,486,988 | 1.10 | 225 | 12,375 |
| Harrison | 3,858,274 | 17,990 | 37,078 | 26,623 | 3,939,965 | 3,557,515 | .90 | 239 | 3,710 |
| Kanawha | 5,405,183 | 70,170 | 74,520 | 38,201 | 5,588,074 | 5,643,180 | 1.01 | 224 | 8,141 |
| Logan | 1,222,576 | 12,148 | 13,798 | .......... | 1,248,522 | 1,205,904 | .97 | 200 | 1,648 |
| McDowell | 6,554,649 | 97,180 | 150,052 | 3,039,094 | 9,840,975 | 10,042,444 | 1.02 | 228 | 11,658 |
| Marion | 3,804,648 | 27,838 | 63,729 | 332,016 | 4,228,231 | 3,927,102 | .93 | 232 | 3,730 |
| Marshall | 469,222 | 129,804 | 13,579 | .......... | 612,605 | 616,834 | 1.01 | 271 | 618 |
| Mason | 97,438 | 49,535 | 3,753 | .......... | 150,726 | 160,951 | 1.07 | 182 | 338 |
| Mercer | 1,785,452 | 13,709 | 45,069 | 500,196 | 2,344,426 | 2,258,267 | .96 | 247 | 2,433 |
| Mineral | 740,487 | 4,279 | 1,902 | .......... | 746,668 | 700,205 | .94 | 260 | 778 |
| Mingo | 2,148,646 | 42,329 | 38,461 | .......... | 2,229,436 | 2,109,965 | .95 | 213 | 2,673 |
| Monongalia | 196,460 | 22,223 | 10,650 | 195,664 | 424,997 | 380,293 | .89 | 262 | 475 |
| Nicholas | 79,309 | 1,660 | 1,277 | .......... | 82,246 | 77,370 | .94 | 148 | 231 |
| Ohio | 140,445 | 44,820 | 2,280 | .......... | 187,545 | 198,985 | 1.06 | 247 | 242 |
| Preston | 883,036 | 30,564 | 30,445 | 342,490 | 1,286,535 | 1,070,757 | .83 | 252 | 1,506 |
| Putnam | 425,109 | 6,422 | 5,542 | .......... | 437,073 | 495,072 | 1.13 | 262 | 893 |
| Raleigh | 1,360,872 | 24,697 | 26,264 | 560 | 1,412,393 | 1,561,471 | 1.11 | 245 | 2,571 |
| Randolph | 453,987 | 36,710 | 15,436 | 165,284 | 671,417 | 636,614 | .95 | 239 | 441 |
| Taylor | 465,445 | 7,760 | 2,032 | .......... | 475,237 | 383,920 | .81 | 168 | 657 |
| Tucker | 764,243 | 11,000 | 28,069 | 413,955 | 1,217,267 | 1,143,072 | .94 | 282 | 1,320 |
| Other counties[b] and small mines | 566,805 | 81,308 | 18,973 | 6,552 | 673,638 | 656,482 | .97 | 237 | 724 |
| Total | 39,942,715 | 932,652 | 773,526 | 6,442,690 | 48,091,583 | 47,846,630 | .99 | 230 | 59,029 |

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[a] Braxton, Gilmer, Hancock, Lewis, Lincoln, Ritchie, and Upshur.

[b] Braxton, Gilmer, Grant, Greenbrier, Hancock, Lewis, Lincoln, Ritchie, and Upshur.

The statistics of production, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table.

*Coal production of West Virginia, by counties, 1903–1907, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Barbour | 742,928 | 666,019 | 615,437 | 993,681 | 1,175,763 | + 182,082 |
| Brooke | 35,025 | 67,706 | 239,396 | 483,256 | 454,119 | − 29,137 |
| Clay | 22,094 | 55,814 | 80,424 | 79,385 | 63,747 | − 15,638 |
| Fayette | 6,092,193 | 7,222,247 | 7,985,327 | 8,260,307 | 8,599,978 | + 339,671 |
| Grant | 78,932 | 161,665 | 207,926 | 297,026 | 312,407 | + 15,381 |
| Hancock | 153,763 | 79,528 | 57,683 | 70,251 | 87,100 | + 16,849 |
| Harrison | 2,504,638 | 2,714,832 | 2,850,678 | 3,626,337 | 3,939,965 | + 313,628 |
| Kanawha | 3,034,912 | 3,134,256 | 3,973,717 | 4,880,307 | 5,588,074 | + 707,767 |
| Logan | ........ | 326 | 223,319 | 592,895 | 1,248,522 | + 655,627 |
| McDowell | 6,108,800 | 6,755,138 | 8,245,167 | 8,707,677 | 9,840,975 | + 1,133,298 |
| Marion | 3,133,699 | 3,407,469 | 3,621,219 | 4,163,462 | 4,228,231 | + 64,769 |
| Marshall | 372,897 | 398,594 | 438,773 | 511,335 | 612,605 | + 101,270 |
| Mason | 127,646 | 117,437 | 95,786 | 112,660 | 150,726 | + 38,066 |
| Mercer | 1,375,780 | 1,761,265 | 2,269,076 | 2,199,830 | 2,344,426 | + 144,596 |
| Mineral | 529,000 | 569,649 | 575,294 | 661,938 | 746,668 | + 84,730 |
| Mingo | 1,164,554 | 1,469,710 | 1,679,526 | 2,210,276 | 2,229,436 | + 19,160 |
| Monongalia | 161,912 | 200,567 | 218,360 | 328,408 | 424,997 | + 96,589 |
| Nicholas | 21,050 | 38,452 | 58,179 | 79,635 | 82,246 | + 2,611 |
| Ohio | 147,232 | 118,725 | 109,201 | 121,464 | 187,545 | + 66,081 |
| Preston | 805,060 | 665,626 | 837,666 | 1,129,344 | 1,286,535 | + 157,191 |
| Putnam | 298,499 | 386,840 | 548,767 | 548,725 | 437,073 | − 111,652 |
| Raleigh | 417,450 | 591,794 | 827,868 | 1,105,318 | 1,412,393 | + 307,075 |
| Randolph | 458,401 | 379,622 | 517,078 | 387,762 | 671,417 | + 283,655 |
| Taylor | 292,146 | 283,332 | 348,105 | 445,427 | 475,237 | + 29,810 |
| Tucker | 1,241,565 | 1,126,883 | 1,095,059 | 1,199,041 | 1,217,267 | + 18,226 |
| Other counties and small mines | 21,957 | 33,256 | 72,549 | 94,603 | 274,131 | + 179,528 |
| Total | 29,337,241 | 32,406,752 | 37,791,580 | 43,290,350 | 48,091,583 | + 4,801,233 |
| Total value | $34,297,019 | $28,647,014 | $32,341,790 | $41,051,939 | $47,846,630 | +$6,794,691 |

For commercial purposes the principal coal-producing regions of West Virginia may be divided into four distinct districts. These may be distinguished by certain geographic or physiographic features. They do not include all of the coal-producing counties of the State, but do include the more important ones, and they contributed over 90 per cent of the total output of the State in 1907. Two of these districts are in the northern part of the State and two in the southern portion. The two in the northern portion are designated, respectively, the Fairmont, or upper Monongahela, district and the Elk Garden, or upper Potomac. Those in the southern portion of the State are the Pocahontas, or Flat Top, district and the New and Kanawha rivers district. The upper Monongahela district is penetrated by the Baltimore and Ohio Railroad, and sends its coal to market over that highway.

The upper Potomac region is also reached by the Baltimore and Ohio Railroad, and is penetrated by the West Virginia Central and Pittsburg Railway. The Pocahontas, or Flat Top, region is tributary to the main branch of the Norfolk and Western Railway. All of the product of this district goes either west or to tide water over that line. The New and Kanawha rivers district is named from the two rivers which drain it, the coal being shipped partly by the Chesapeake and Ohio Railway and the Kanawha and Michigan Railway, which pass through it, and partly by barges on the Kanawha River. The most important district from the productive point of view is that of the New and Kanawha rivers, which embraces the counties of

Fayette, Kanawha, Raleigh, and Putnam. The coal from these four counties is drawn from two different areas, most of the coal from Kanawha and Putnam counties being from a higher geologic horizon than that of Fayette and Raleigh counties, but the district is practically compact and continuous and is drained by the same waters and reached by the same railroads, so the two areas are considered as one district in this report.

*Coal production of the principal districts of West Virginia, 1886–1907, in short tons.*

| Year. | New and Kanawha rivers district.[a] | Pocahontas, or Flat Top, district.[b] | Fairmont, or Upper Monongahela, district.[c] | Upper Potomac, or Elk Garden, district.[d] |
|---|---|---|---|---|
| 1886 | 2,290,563 | 968,484 | 406,976 | 383,712 |
| 1887 | 2,379,296 | 1,357,040 | 520,064 | 503,343 |
| 1888 | 2,840,630 | 1,912,695 | 473,489 | 518,878 |
| 1889 | 2,669,016 | 2,290,270 | 456,582 | 666,956 |
| 1890 | 3,012,414 | 2,702,092 | 600,131 | 819,062 |
| 1891 | 3,632,209 | 3,137,012 | 1,150,569 | 1,052,308 |
| 1892 | 3,773,021 | 3,503,260 | 1,141,430 | 942,154 |
| 1893 | 4,099,112 | 3,815,280 | 1,255,956 | 1,129,397 |
| 1894 | 3,650,971 | 5,059,025 | 1,655,532 | 927,220 |
| 1895 | 4,399,623 | 4,044,998 | 1,550,256 | 1,125,601 |
| 1896 | 4,650,455 | 4,608,113 | 1,743,590 | 1,245,012 |
| 1897 | 4,921,701 | 4,859,373 | 2,074,663 | 1,425,026 |
| 1898 | 5,947,272 | 5,521,160 | 2,525,294 | 1,531,562 |
| 1899 | 6,544,956 | 6,033,344 | 3,374,183 | 1,786,009 |
| 1900 | 7,804,879 | 6,901,637 | 4,187,630 | 1,909,797 |
| 1901 | 8,427,574 | 6,736,107 | 5,174,160 | 1,856,677 |
| 1902 | 7,089,805 | 7,431,687 | 5,463,791 | 2,581,218 |
| 1903 | 9,843,063 | 8,319,775 | 5,638,337 | 2,229,065 |
| 1904 | 11,429,403 | 10,858,159 | 7,937,845 | 1,858,197 |
| 1905 | 13,474,282 | 13,378,468 | 8,491,465 | 1,878,279 |
| 1906 | 14,953,677 | 14,621,316 | 10,686,659 | 2,158,005 |
| 1907 | 16,183,511 | 16,779,893 | 11,530,728 | 2,276,342 |

[a] Includes Clay, Fayette, Kanawha, Nicholas, Putnam, and Raleigh counties.
[b] Includes Logan, McDowell, Mercer, and Mingo counties, and Tazewell County, Va.
[c] Includes Barbour, Harrison, Marion, Monongalia, Preston, and Taylor counties.
[d] Includes Grant, Mineral, and Tucker counties.

In order to show the great increase made by West Virginia as a coal-producing State, the following table has been prepared. The statement shows that in 26 years there has been only one exception to a steadily increasing output, and that during the period the average increase has exceeded 1,785,000 tons.

*Annual increase in the coal production of West Virginia, 1881–1907, in short tons.*

| Year. | Quantity. | Year | Quantity. |
|---|---|---|---|
| 1882 over 1881 | 560,000 | 1896 over 1895 | 1,488,335 |
| 1883 over 1882 | 95,853 | 1897 over 1896 | 1,371,863 |
| 1884 over 1883 | 1,024,167 | 1898 over 1897 | 2,452,840 |
| 1885 over 1884 | 9,062 | 1899 over 1898 | 2,551,996 |
| 1886 over 1885 | 636,734 | 1900 over 1899 | 3,394,212 |
| 1887 over 1886 | 875,824 | 1901 over 1900 | 1,421,195 |
| 1888 over 1887 | 617,180 | 1902 over 1901 | 502,424 |
| 1889 over 1888 | 733,080 | 1903 over 1902 | 4,766,415 |
| 1890 over 1889 | 1,162,774 | 1904 over 1903 | 3,069,511 |
| 1891 over 1890 | 1,826,011 | 1905 over 1904 | 5,384,828 |
| 1892 over 1891 | 518,090 | 1906 over 1905 | 5,498,770 |
| 1893 over 1892 | 969,823 | 1907 over 1906 | 4,801,233 |
| 1894 over 1893 | 919,179 | | |
| Total increase in 13 years | 9,947,757 | Total increase in 26 years | 46,411,583 |
| Decrease in 1895 | 239,796 | | |
| Total increase in 14 years | 9,707,961 | Average annual increase | 1,785,061 |

The coal-producing area of West Virginia is included in the coal fields of the Appalachian region, which crosses the State from Pennsylvania and Maryland on the north to Virginia and Kentucky on the south. Only the area lying to the east of the escarpment of the Allegheny Mountains is outside of the coal-bearing rocks, although a large part of the region lying along the Ohio River south of Wetzel County is said, by Dr. I. C. White, State geologist, to be barren of workable coal. All of the coals of West Virginia belong to the bituminous or semibituminous varieties, but some cannel and a peculiar grade known as Kanawha splint are mined in the southern part of the State. One of the most important seams in the State is the celebrated Pittsburg bed of Pennsylvania, which extends over a considerable portion of West Virginia and Ohio.

Of West Virginia's total production about 90 per cent comes from five principal mining districts, and nearly all of the other 10 per cent comes from three smaller districts. The more important of these are the Fairmont, or Clarksburg, and the Piedmont, or Elk Garden, fields in the northern portion of the State, and the New River, Kanawha, and Pocahontas fields in the southern portion.

The Fairmont, or Clarksburg, region lies principally in Harrison and Marion counties, the beds from which the coal is mined here belonging to the Upper Productive Coal Measures. The most important bed is the Pittsburg, which has an average thickness of 8 feet 6 inches, of which 7 feet are usually mined. The Waynesburg and Sewickley coals, the former poor and the latter good, also occur in this district, and run from 5 to 10 feet in thickness, but are seldom mined. The field is penetrated by the Baltimore and Ohio Railroad, which furnishes transportation for the product.

The Piedmont, or Elk Garden, field was the first to be worked in West Virginia, coal having been mined in this district before the State was separated from the mother State of Virginia, and also contemporaneously with the opening of the Cumberland, or Georges Creek, field in Maryland. It is a part of the detached portion of the great coal fields lying in Mineral, Grant, and Tucker counties, where the coal beds are somewhat folded. The coal approaches semibituminous in character. Two coals belonging in the "Lower Productive Measures" are worked. They are known as the "E," or Upper Freeport, and the "B," or Lower Kittanning, and range from 4 to 11 feet in thickness. Transportation is afforded by the Baltimore and Ohio and the West Virginia Central and Pittsburg railroads, the latter being now a portion of the Wabash system.

The New River field, as at present outlined, is confined to the valley of the New River and its tributaries, the productive portions being in Fayette and Raleigh counties. The coals of this district occur in the lower Pottsville series, which lies below the "Lower" and "Upper Productive Measures" of the northern part of the State. The two beds which furnish the larger part of the product are the Sewell, which runs from 2 feet 6 inches to 5 feet, and the Quinnimont, from 3 feet to 5 feet in thickness, the latter lying below and to the southeast of the former. The coal is of the "smokeless" coking variety, not unlike in quality that of the Piedmont field. One seam of coal, belonging properly to the Kanawha field, lies high in the hills in the New River district, and is extensively mined at Ansted, in Fayette County. The district is penetrated by the Chesapeake and Ohio Railroad, which follows the course of the New River and furnishes transportation for the product.

The Kanawha field lies immediately west of the New River field and includes the western portion of Fayette County, all of Kanawha County, and a portion of Putnam County. It is drained by the Kanawha and the Elk rivers. The coals of this field occur at a higher geological horizon than those of the New River district and belong to the "Lower Productive" and upper Pottsville measures. The coals are variable in character and thickness. The beds usually vary from 3 to 5 feet in thickness where mined, but in some cases reach as high as 11 feet or more in thickness. A considerable portion of the coal is a high-grade, gas-producing fuel, Kanawha gas coal having an excellent reputation for this purpose. The principal beds are designated as the North Coalburg, the No. 5, the Belmont, the Coalburg, the Winifrede, the Cedar Grove, "No. 2, gas," and the Eagle. Transportation is furnished by the Chesapeake and Ohio, the Kanawha and Michigan, and the recently constructed Coal and Coke and Virginian (Deepwater-Tidewater) railroads. The slack-water navigation of the Kanawha River also affords an outlet to market for the Kanawha coals.

The Pocahontas field lies in the southeastern corner of the State, in McDowell and Mercer counties, and extends across the State line into Tazewell County, Va. The coal mined in the Pocahontas, or No. 3 seam, is from 4 to 11 feet in thickness, averaging over 6 feet. During the last few years a large amount of development has been done on Pocahontas No. 4 and the Welch beds, and shipments from these beds have reached an important character. All of these occur near the bottom of the Pottsville series. All of the Pocahontas coal is a high-grade, semibituminous variety, one of the purest coals occurring in the United States. It is the only rival as a coke producer to the Connellsville coal of Pennsylvania, and as a steam fuel ranks with the Georges Creek, Cumberland of Maryland, and the best Clearfield coals of Pennsylvania. This district is penetrated by the Norfolk and Western Railroad, over which the product is shipped to market.

The smaller fields include the coals of the Big Sandy in Mingo County, in the southern portion of the State, this being in reality a continuation of the Kanawha field, with transportation afforded by the Norfolk and Western Railroad; of the Philippi field, in Preston, Barbour, and Randolph counties, which belongs to the "Lower Productive Measures" in the northern part of the State, and the Wheeling field, which includes the counties in the Panhandle along the Ohio River, where the Pittsburg coal is mined.

The statistics of production in West Virginia since 1863, when the State was formed out of Virginia, are shown in the table on a preceding page, giving the production of coal in the United States from the earliest times to the close of 1907.

The total production of coal in West Virginia to the close of 1907 amounted to 434,198,539 short tons, equivalent to an exhaustion of 650,000,000 tons. Mr. Campbell states in his estimate that the total area containing workable coal in West Virginia is 17,000 square miles, and that the original supply when mining began was 231,039,000,000 short tons, or a little more than double the supply of Pennsylvania bituminous coal. Deducting the exhaustion to the close of

1907, there still remains available 230,389,000,000 short tons, nearly 4,800 times the production of 1907, or 3,200 times the exhaustion represented by the 1907 output.

## WYOMING.

Total production in 1907, 6,252,990 short tons; spot value, $9,732,668.

In Wyoming as in the other important coal-producing States of the Rocky Mountain region, the production of coal in 1907 exceeded that of any preceding year. Compared with 1906, the output of Wyoming in 1907 showed an increase of 118,996 short tons, or 1.94 per cent. The gain in production was, however, insignificant when compared with the gain in value, for while the production increased from 6,133,994 short tons in 1906 to 6,252,990 tons in 1907, the value increased from $8,013,528 to $9,732,668, a gain of $1,719,140, or 21.45 per cent. The greater part of this comparatively large increase in value was due to the favorable conditions which existed during the first nine months of the year, when the demand was good, labor scarce, and prices accordingly advanced; but it is also true that a part of the increase in value was due to a reduction in the working time at many of the mines, when in September the working hours per day were reduced from 10 to 8. At the same time the rates of wages were advanced, and operators have claimed that the shorter hours and advanced pay resulted in a decrease in labor efficiency. This increased the mining cost, which had to be made up by higher prices for the coal sold.

Some color to the claim of decreased efficiency is given by the returns for 1907, which show that the average production per day per man was 3.42 tons, as against 3.68 tons in 1906, and 3.97 tons in 1905. The average production per man employed for the year 1907 was 941 tons, as against 1,033.7 tons in 1906 and 937.3 tons in 1905. The coal mines of Wyoming gave employment in 1907 to 6,645 men for a period of 275 days, against 5,934 men for 281 days in 1906, and 5,977 men for an average of 236 days in 1905.

The statistics relating to the use of mining machines show that there were, in 1907, 79 coal-cutting machines in use in the mines of Wyoming, compared with 83 in 1906 and 81 in 1905. The machine-mined production decreased slightly from 1,339,422 tons in 1906 to 1,328,709 tons in 1907. In 1905 there were 1,236,750 tons mined by machines in Wyoming. Of the total number of machines used in 1907, 45 were of the pick or puncher type, 33 were chain-breast, and 1 long-wall.

The statistics of production, by counties, in 1906 and 1907, with the distribution of the product for consumption, are shown in the following table:

*Coal production of Wyoming, in 1906 and 1907, by counties, in short tons.*

| County. | Loaded at mines for shipment. | Sold to local trade and used by employees. | Used at mines for steam and heat. | Made into coke. | Total quantity. | Total value. | Average price per ton. | Average number of days active. | Average number of employees. |
|---|---|---|---|---|---|---|---|---|---|
| **1906.** | | | | | | | | | |
| Converse | 58,418 | 1,622 | 9,455 | ........ | 69,495 | $122,241 | $1.76 | 251 | 105 |
| Sheridan | 961,515 | 18,593 | 34,210 | ........ | 1,014,318 | 1,191,569 | 1.17 | 284 | 902 |
| Sweetwater | 2,035,601 | 11,705 | 74,240 | ........ | 2,121,546 | 2,911,316 | 1.37 | 274 | 2,229 |
| Uinta | 1,980,444 | 9,276 | 89,052 | ........ | 2,078,772 | 2,620,228 | 1.26 | 277 | 1,750 |
| Other counties[a] | 765,645 | 16,895 | 64,103 | 1,655 | 848,298 | 1,164,712 | 1.37 | 298 | 948 |
| Small mines | ........ | 1,565 | ........ | ........ | 1,565 | 3,462 | 2.21 | ........ | ........ |
| Total | 5,801,623 | 59,656 | 271,060 | 1,655 | 6,133,994 | 8,013,528 | 1.31 | 281 | 5,934 |
| **1907.** | | | | | | | | | |
| Sheridan | 1,162,830 | 22,612 | 40,779 | ........ | 1,226,221 | $2,112,003 | $1.72 | 259 | 1,425 |
| Sweetwater | 1,988,760 | 9,185 | 73,897 | ........ | 2,071,842 | 3,134,799 | 1.51 | 288 | 2,092 |
| Uinta | 1,780,306 | 8,293 | 101,143 | ........ | 1,889,742 | 2,844,805 | 1.51 | 284 | 1,830 |
| Other counties[b] | 949,159 | 33,171 | 82,115 | ........ | 1,064,445 | 1,639,249 | 1.54 | 257 | 1,298 |
| Small mines | ........ | 740 | ........ | ........ | 740 | 1,812 | 2.45 | ........ | ........ |
| Total | 5,881,055 | 74,001 | 297,934 | ........ | 6,252,990 | 9,732,668 | 1.56 | 275 | 6,645 |

[a] Bighorn, Carbon, Crook, Johnson, and Weston.
[b] Bighorn, Carbon, Converse, Crook, Fremont, Johnson, and Weston.

The statistics of the production of coal, by counties, during the last five years, with the increases and decreases in 1907 as compared with 1906, are shown in the following table:

*Coal production of Wyoming, 1903–1907, by counties, in short tons.*

| County. | 1903. | 1904. | 1905. | 1906. | 1907. | Increase (+) or decrease (−), 1907. |
|---|---|---|---|---|---|---|
| Bighorn | ........ | 6,235 | 4,605 | 4,743 | 56,966 | + 52,223 |
| Carbon | 243,323 | 336,292 | 354,358 | 450,636 | 583,402 | + 132,766 |
| Converse | 91,050 | 77,386 | 64,939 | 69,495 | 48,700 | − 20,795 |
| Sheridan | 455,309 | 554,785 | 742,314 | 1,014,318 | 1,226,221 | + 211,903 |
| Sweetwater | 1,628,944 | 1,992,993 | 2,113,979 | 2,121,546 | 2,071,842 | − 49,704 |
| Uinta | 1,782,668 | 1,800,069 | 1,897,668 | 2,078,772 | 1,889,742 | − 189,030 |
| Weston | 416,974 | 398,367 | 409,690 | 379,990 | 361,015 | − 18,975 |
| Crook<br>Fremont<br>Johnson<br>Natrona | 14,934 | 9,254 | 11,798 | [a] 12,929 | [b] 14,362 | + 1,433 |
| Small mines | 2,091 | 3,175 | 2,670 | 1,565 | 740 | − 825 |
| Total | 4,635,293 | 5,178,556 | 5,602,021 | 6,133,994 | 6,252,990 | + 118,996 |
| Total value | $5,731,281 | $6,747,909 | $7,336,951 | $8,013,528 | $9,732,668 | +$1,719,140 |

[a] Crook and Johnson only.
[b] Crook, Fremont, and Johnson.

Coal-bearing formations underlie about 50 per cent of the State of Wyoming. The largest area in the State known to contain workable coal lies east of the Bighorn Mountains and extends from Douglas northward to the State line. It is the southern extension of what is designated as the Black Hills region, the great coal area of eastern Montana and northeastern Wyoming, and contains in Wyoming about 14,590 square miles, of which 11,530 square miles are known to contain workable coal, and of which 3,060 square miles are not so well known but may contain workable beds. The next largest area is the Green River region, of which there are 4,855 square miles containing workable coal and 1,350 which may do so. In addition to this there are 20,000 square miles in this region which may contain workable coal, but if so the coal is at such depth as not to be workable under present conditions. The productive area of this region extends along the Union Pacific Railroad from Rock Springs to Rawlins. The Carbon County, or Hanna, coal field extends from Medicine Bow to Fort Steele along the Union Pacific Railroad, south of the Freezeout and Seminoe Mountains and north of the Medicine Bow and Sierra Madre uplifts. It contains an area of 1,435 square miles. The Hams Fork region, in the extreme western portion of the State and extending into Idaho, contains 1,073 square miles known to contain workable coals and 960 square miles not well known but which may contain workable coal. There are 115 square miles in this region in which the coal has such heavy covering as not to be considered as minable under present conditions.

The Bighorn Basin region, lying in the northwestern portion of the State about halfway between the Black Hills region and the western State line, is an important area on which little exploitation work has been done. This region contains 905 square miles of known workable coal beds, 430 square miles which may contain workable coal, and 2,830 square miles of coal under very heavy covering. The Black Hills region is in the northeastern part of the State and has 320 square miles of area containing workable coal. Mining is carried on in this region at Aladdin in Crook County and Cambria in Weston County.

Wyoming is the second largest producing State in the Rocky Mountain region, Colorado ranking first, and if production in Wyoming continues to increase in the next few years as it has done in the last twenty-five it will soon rival Colorado for the first place in the region. The largest proportion of the producing area in Wyoming is included within the basin region along the Union Pacific Railroad from Hanna westward to the State line and west of the main Rocky Mountain uplift. All the coal mined in Wyoming is bituminous or subbituminous in character, the larger proportion being bituminous. More than half of the coal produced comes from the Hams Fork region in Uinta County and from the Green River region in Sweetwater County. These are, strictly speaking, the only bituminous coals mined within the State. The Hams Fork or Uinta County coal is high-grade bituminous, while practically all of the coal mined in the Rock Springs-Rawlins fields of the Green River region falls just within the lower limit of bituminous coals, as does also the coal from the Cambria field of the Black Hills region in Weston County. Among the more important areas producing subbituminous coal are the Carbon County or Hanna field, which is being developed rather extensively at Hanna by the Union Pacific Coal Company; the Douglas-Sheridan coal field of the Fort Union region, which is being developed at Glenrock and

Big Muddy in Converse County and near Sheridan in Sheridan County; the Bighorn Basin coal field in Bighorn County; and the Almy coal field of the Hams Fork region in Uinta County. Other fields which have been reached by the railroad and are of minor importance are the Aladdin field of the Black Hills region in Crook County; the Sublette field of the Hams Fork region in Uinta County; and the Lander field of Fremont County. The fields which have not been reached by the railroad are as follows: Henrys Fork field in southern Sweetwater County; the Rattlesnake field in Natrona and Fremont Counties; the Owl Creek Mountain field in the Shoshone Indian Reservation in Fremont County; the Fall River basin and Upper Green River field in Uinta and Fremont counties; the Mount Leidy field, the Lander Peak field, and the Grays River field, in Uinta County.

The estimate of the original coal supply of Wyoming, as made by Mr. Marius R. Campbell, of the United States Geological Survey, credited that State with the largest original supply, with the single exception of North Dakota, which is estimated to have contained originally 500,000,000,000 short tons of coal. The areas of North Dakota are, however, entirely of lignite, while in Wyoming the coal is either of bituminous or of subbituminous character. Wyoming's supply is estimated to have been 424,085,000,000 short tons, compared with which the aggregate production to the close of 1907 (77,818,765 short tons) appears insignificant. The total exhaustion of the beds up to the close of 1907 amounted to 116,000,000 short tons, or 0.027 of 1 per cent of the total estimated supply.

# CLASSIFIED LIST OF PAPERS DEALING WITH COAL, COKE, LIGNITE, AND PEAT CONTAINED IN PUBLICATIONS OF U. S. GEOLOGICAL SURVEY.

Compiled by WILLIS T. LEE and JOHN M. NICKLES.

The following list contains the more important papers dealing with coal, coke, lignite, and peat, from an economic standpoint, except the statistical reports contained in the volumes of Mineral Resources. The page references indicate whether a paper is devoted wholly, or in part, to these subjects.

Papers dealing with geologic work in the several States and Territories, alphabetically arranged, are given first, then those general in scope arranged in chronologic order, followed by papers on technologic subjects.

## ALABAMA.

The coal measures of Alabama, by E. A. Smith. Mineral Resources U. S. for 1892, 1893, pp. 293–300.

Stevenson folio, Alabama-Georgia-Tennessee, description, by C. W. Hayes. Geologic Atlas U. S., folio 19, 1895.

Gadsden folio, Alabama, description, by C. W. Hayes. Geologic Atlas U. S., folio 35, 1896.

The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227–263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The Warrior coal basin in the Brookwood quadrangle, Alabama, by Charles Butts. Bull. No. 260, 1905, pp. 357–381.

The Warrior coal basin in the Birmingham quadrangle, Alabama, by Charles Butts. Bull. No. 285, 1906, pp. 211–222.

The northern part of the Cahaba coal field, Alabama, by Charles Butts. Bull. No. 316, 1907, pp. 76–115.

## ALASKA.

The mining industry in 1905, by A. H. Brooks. Bull. No. 284, 1906, pp. 4–9.

The mining industry in 1906, by A. H. Brooks. Bull. No. 314, 1907, pp. 19–39.

The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bull. No. 250, 1905, 64 pp.

Markets for Alaska coal, by G. C. Martin. Bull. No. 284, 1906, pp. 18–29.

The Alaska coal fields, by G. C. Martin. Bull. No. 314, 1907, pp. 40–46.

Bering River coal field, by G. C. Martin. Bull. No. 259, 1905, pp. 140–150.

Coal resources of southwestern Alaska, by R. W. Stone. Bull. No. 259, 1905, pp. 151–171.

Mineral resources of the Kenai Peninsula; coal fields of the Kachemak Bay region, by R. W. Stone. Bull. No. 277, 1906, pp. 53–73.

Preliminary statement on the Matanuska coal field, by G. C. Martin. Bull. No. 284, 1906, pp. 88–100.

A reconnaissance of the Matanuska coal field, Alaska, in 1905, by G. C. Martin. Bull. No. 289, 1906, 36 pp. (Out of stock; can be purchased of Superintendent of Documents for 25 cents.)

The Herendeen Bay coal field, by Sidney Paige. Bull. No. 284, 1906, pp. 101-108.

The coal resources of the Yukon, Alaska, by A. J. Collier. Bull. No. 218, 1903. 71 pp.

Coal fields of the Cape Lisburne region, by A. J. Collier. Bull. No. 259, 1905, pp. 172-185.

### ARIZONA.

Report of work done in the division of chemistry and physics mainly during the fiscal year 1884-85. Bull. No. 27, 1886. p. 74.

Gives analyses of coal from Deer Creek Valley, Ariz.

The Deer Creek coal field, Arizona, by M. R. Campbell. Bull. No. 225, 1904, pp. 240-258.

### ARKANSAS.

The coal fields of Arkansas, by J. C. Branner. Mineral Resources U. S. for 1892, 1893, pp. 303-306.

Preliminary report on the Camden coal field of southwestern Arkansas, by J. A. Taff. Twenty-first Ann. Rept., pt. 2, 1900, pp. 313-329.

The southwestern coal field, by J. A. Taff. Twenty-second Ann. Rept., pt. 3, 1902, pp. 367-413.

An account of the coals of Arkansas, Indian Territory, and northern Texas.

Fayetteville folio, Arkansas-Missouri, description, by G. I. Adams and E. O. Ulrich. Geologic Atlas U. S., folio 119, 1905, p. 6.

The Arkansas coal field, by A. J. Collier. Bull. No. 316, 1907, pp. 137-160.

The Arkansas coal field, by A. J. Collier, with reports on the paleontology by David White and G. H. Girty. Bull. No. 326, 1907. 158 pp.

Winslow folio, Arkansas-Indian Territory, description, by A. H. Purdue. Geologic Atlas U. S., folio 154, 1907, p. 6.

### CALIFORNIA.

The coal deposits of California, by H. W. Turner. Mineral Resources U. S. for 1892, 1893, pp. 308-310.

Sacramento folio, California, description, by Waldemar Lindgren. Geologic Atlas U. S., folio 5, 1894.

Jackson folio, California, description, by H. W. Turner. Geologic Atlas U. S., folio 11, 1894.

Lassen Peak folio, California, description, by J. S. Diller. Geologic Atlas U. S., folio 15, 1895.

Marysville folio, California, description, by Waldemar Lindgren and H. W. Turner. Geologic Atlas U. S., folio 17, 1895.

The coal fields of the Pacific coast, by G. O. Smith. Twenty-second Ann. Rept., pt. 3, 1902, pp. 473-513.

An account of the coals occurring in Washington, California, and Oregon.

Coal in the Mount Diablo Range, Monterey County, Cal., by Ralph Arnold. Bull. No. 285, 1906, pp. 223-225.

Coal of Stone Canyon, Monterey County, Cal., by M. R. Campbell. Bull. No. 316, 1907, pp. 435-438.

### COLORADO.

A report of work done in the division of chemistry and physics mainly during the fiscal year 1888-89, by F. W. Clarke. Bull. No. 64, 1890, p. 55.

Gives analyses of coals from Gunnison County, Colo.

Coal fields of Colorado, by R. C. Hills. Mineral Resources U. S. for 1892, 1893, pp. 319-365.

Anthracite-Crested Butte folio, Colorado, description of the sedimentary formations, by G. H. Eldridge. Geologic Atlas U. S., folio 9, 1894.

Geology of the Denver basin in Colorado: Economic geology, by G. H. Eldridge. Monograph XXVII, 1896, pp. 317-387.

Elmoro folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 58, 1899.

La Plata folio, Colorado, description: Economic geology, by C. W. Purington, Geologic Atlas U. S., folio 60, 1899, p. 14.

Walsenburg folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 68, 1900, pp. 4-5.

Spanish Peaks folio, Colorado, description, by R. C. Hills. Geologic Atlas U. S., folio 71, 1901, pp. 4–6.

The Rocky Mountain coal fields, by L. S. Storrs. Twenty-second Ann. Rept., pt. 3, 1902, pp. 415–471.

Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper No. 32, 1905, pp. 372–379.

Gives a general account of the occurrence of coal in Colorado, Wyoming, South Dakota, and Nebraska.

The Yampa coal field, Routt County, Colo., by N. M. Fenneman and H. S. Gale. Bull. No. 285, 1906, pp. 226–239.

The Durango-Gallup coal field of Colorado and New Mexico, by F. C. Schrader. Bull. No. 285, 1906, pp. 241–258.

The Yampa coal field, Routt County, Colo., by N. M. Fenneman and H. S. Gale. With a chapter on the character and use of the Yampa coals by M. R. Campbell. Bull. No. 297, 1906. 96 pp.

Coal fields of the Danforth Hills and Grand Hogback, in northwestern Colorado, by H. S. Gale. Bull. No. 316, 1907, pp. 264–301.

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Mineral resources of the Bighorn basin, by C. A. Fisher. Bull. No. 285, 1906, pp. 311–315.

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Binders for coal briquets, by J. E. Mills. Bull. No. 343, 1908. 56 pp.

Combustion of briquets on locomotives, by W. F. M. Goss and E. D. Nelson. Bull. No. 341, 1908. —— pp. (In press.)

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# COAL BRIQUETTING IN 1907.

By Edward W. Parker.

That considerable progress was made in the development of a briquetting industry in the United States in 1907 is shown by the reports of operations made to the Geological Survey for that year. There were eleven plants in actual operation during 1907, although one of these, that of the Pittsburg Coal Mining Company, at Pittsburg Landing, Cal., was burned in July and had not been rebuilt up to the close of the year. The total production of briquets, as reported to the Survey, amounted to 66,524 short tons, having a value at the plants of $258,426. When compared with the development of this industry in Germany (in which country the production of briquets in 1906 amounted to about 16,000,000 short tons), the production in the United States appears insignificant, but it is of importance as indicating that a beginning has been made, and with the success of the established plants demonstrated and the gradual education of consumers in the advantages of briquets for efficiency, ease of handling, and cleanliness, rapid progress should be made in this industry during the next few years.

As constant dropping of water wears away the stone, so the constant agitation of this subject has begun to show its effect, and the rock of opposition, or at least of inaction, is being worn away. There can be little doubt that the interest aroused through calling attention to the waste of that part of the country's natural resources, represented by the nonuse of the slack and culm produced in our coal-mining operations, and the aggressive policy of President Roosevelt in seeking to throw light upon it and to correct the abuses into which we have largely unconsciously fallen, are to a great extent responsible for the present prospect of a development of coal briquetting, as an important industry in the United States. It may not be long before the governments of the States, under whose jurisdiction the matter comes, will enact legislation against the accumulation of slack and culm heaps or their useless destruction by burning, and prohibit this waste, as they have in some cases interdicted the waste of natural gas.

Legislation which would prohibit "shooting from the solid" at mines, when the slack coal is not a marketable product, and which would provide penalties for excessive use of powder, would have, as one result, a larger percentage of lump coal, and thus, in part at least, enable operators to assume the additional expense involved in the briquetting of such slack coal as is unavoidably produced.

There were eleven coal briquetting plants in the United States, each manufacturing briquets, during 1907. The location of these plants and the character of the fuel and binder used in the operations are as follows:

*Arizona Copper Company, Clifton, Ariz.*—This company uses bituminous coal, mined in New Mexico, with an asphaltic pitch made from California crude petroleum. The briquets weigh approximately 4 pounds each and are used under the boilers of the company's plant. The briquetting machine is of English design and is described in the United States Geological Survey Bulletin 316, published in 1907. The capacity of the machine is 24 tons in a day of ten hours.

*Western Fuel Company, Oakland, Cal.*—This plant, which is also described in Bulletin 316, operates on bituminous coal slack or screenings with asphaltic pitch, with proportions of 90 per cent of coal and 10 per cent of binder. The capacity of the machine is 60 tons in a day of ten hours. The operations of the company were begun in June, 1905. The briquets are cubical in shape, with rounded edges, and weigh approximately 10 ounces each. They are used principally for domestic purposes.

*Pittsburg Coal Mining Company, Pittsburg Landing, Cal.*—This plant was put into operation during the first six months of 1907, but was burned in July. It was operated upon screenings from the coal yards of San Francisco, using asphaltic pitch as a binder in the proportions of 92 per cent of coal and 8 per cent of pitch. The briquets are of semicylindrical pattern, weighing about 8 ounces each and are used principally for domestic purposes.

*Indianapolis Briquetting Company, Indianapolis, Ind.*—This company began installing briquetting machinery in 1906 and commenced operations in November, 1907, using 92 per cent bituminous coal slack and 8 per cent of coal-tar pitch. The briquets are of cylindrical shape, weighing 5 ounces when intended for domestic purposes. Larger sized briquets can be made, if desired, the capacity of the machine depending upon the size of the briquets.

*Semet-Solvay Company, Detroit, Mich.*—The briquetting plant of the Semet-Solvay Company, located at Delray, Mich., is operated in connection with the plant of the Semet-Solvay by-product coke ovens at that place and is intended primarily to make available for use the coke "breeze" produced at the ovens. As originally designed (early in 1905) this plant contained a Johnson (English) briquetting press, but the product, on account of the large size of the briquets, was not found adapted to the market and a Mashek type of press was substituted. The new machine was started in August, 1907. Another machine, producing the eggette or ovoid-shaped briquet, has been purchased but has not been delivered. When the new machine is installed the plant will have a capacity of nearly 20 tons an hour. The present practice consists in using a mixture of 50 to 75 per cent of bituminous coal slack and 50 to 25 per cent of coke breeze. From 91 to 95 per cent of this mixture is used with 9 to 5 per cent of coal tar pitch. The briquets weigh about 2 ounces each.

*Western Coalette Fuel Company, Kansas City, Mo.*—This company is operating a Renfrow machine, the type of which, described in

Bulletin 316, formed a part of the equipment of the Geological Survey coal-testing plant at St. Louis, Mo., subsequent to the exposition period and later at the Jamestown Exposition. The machine was installed in Kansas City in April, 1907, and is operating upon semianthracite slack from Arkansas and Oklahoma and bituminous coal slack from Kansas and Missouri, using coal-tar pitch as a binder in proportions of 94 per cent of coal and 6 per cent of binder. The briquets are cylindrical in shape with convex ends, weighing approximately 14 ounces. They are intended for household, locomotive, and stationary boiler use. The capacity of the machine, of which there was only one installed at the close of 1907, is 8 tons per hour. The operations during the year were largely of an experimental character and considerable construction work was carried on at the same time.

*D. Grieme Coal Company, foot of West 47th street, New York, N. Y.*—This plant, among those described in Bulletin 316, was put into operation in October, 1907. The press is of Mashek design and makes a small, rectangular, convex briquet which is intended entirely for domestic purposes. They weigh approximately 2 ounces each. The coal used is anthracite No. 3 buckwheat and culm with coal-tar pitch as a binder, the proportions being 93 to 94 per cent of coal and 6 to 7 per cent of binder. The capacity of the machine is rated at 13 tons of briquets per hour.

*The National Fuel Briquette Machinery Company, foot of Court street, Brooklyn, N. Y.*—This plant is also described in Bulletin 316, and consists of a Belgian type press manufacturing small eggettes which weigh less than 2 ounces each. It is operated on anthracite culm and coal-tar pitch with proportions of 95 per cent of coal to 5 per cent of pitch. The eggettes are intended primarily for household use, and the principal market is in the domestic trade of Brooklyn. They are also used to some extent for stationary boilers. The capacity of the machine is rated at 6 tons per hour.

*The Scranton Anthracite Briquette Company, Dickson City, Pa.*—This plant was the largest producer of briquets in the United States during 1907, although it was operated only seven months during the year. The plant is located adjacent to one of the Delaware, Lackawanna and Western mines, near Dickson City, and the briquets are used on the locomotives of that railroad. Anthracite culm is used exclusively with a patented binder of which coal-tar pitch is a principal ingredient. The company prefers not to publish the proportions of coal and pitch used. The briquets are of eggette pattern, weighing about 8 ounces each. During the year the company was engaged in enlarging its plant, and for this reason operations were carried on during only seven months of the year. When the extension work is completed the company expects to have a capacity of 10,000 or 12,000 tons of briquets per month.

*The Briquette Coal Company, Staten Island, N. Y.*—This plant, which was completed in July, 1906, and which was briefly described in Bulletin 316, consists of two presses, one of German type and one of Belgian type, the briquets made in the former weighing approximately 1 pound each and those in the Belgian about 4 ounces each. The machines have a capacity of respectively 4½ and 7½ tons per hour. The plant is operated on a mixture of anthracite culm and bituminous slack coal and also on anthracite alone with a binder, of which coal-tar pitch is the basis. The company does not care to give details as to the binder or the percentages used.

*The United Gas Improvement Company, Point Breeze, Philadelphia, Pa.*—As stated in the report on the Coal Briquetting Industry in 1906, published in Bulletin 316, this plant is operated primarily for the purpose of utilizing the breeze produced at the gas works of th company. It is found advantageous to mix the coke breeze with anthracite culm and bituminous slack in addition to the binding material. The average mixture is 42 per cent anthracite culm, 13 per cent bituminous slack, 35 per cent coke breeze, and 10 per cent water-gas pitch. The briquets weigh approximately 5 ounces each, are of eggette pattern, and are charged into retorts and used in the manufacture of water gas. There are two machines in the plant, both of Belgian type, which have a capacity of 50 tons per day.

In addition to the preceding list of plants, all of which were in operation in 1907, the following companies have been organized for the purpose of establishing coal-briquetting plants. This list does not include any of the names published in Bulletin 316 which have passed out of existence or from which no replies were received from inquiries sent asking for information regarding the operations of the plants during 1907:

*The Standard Fuel Company, Birmingham, Ala.*—A new company, incorporated in 1907; it did not produce any commercial briquets during the year.

*The United States Briquetting Company, San Francisco, Cal.*—This company was organized for the purpose of exploiting a process for briquetting peat with California petroleum. All of the work so far has been of an experimental character.

*North American Coal Briquetting Company, 81 New street, New York, N. Y.*—This company was organized for exploiting the Forst briquetting process, the main feature of which consists in the material to be used as binder. It consists principally of coal-tar pitch, but the other ingredients of the binding material are kept secret and the process is a patented one. The company has not yet begun operation on a commercial scale.

*Zwoyer Fuel Company, 60 Wall street, New York, N. Y.*—The plant of this company, which is described in Bulletin 316, was removed from Brooklyn, N. Y., to Perth Amboy, N. J., during 1907, and was not operated during the year.

*American Briquetting and Manufacturing Company, Williston, N. Dak.*—This company was organized for the purpose of briquetting North Dakota lignite, using 94 per cent of lignite and 6 per cent of binder composed of flax-fiber sirup and rosin. The briquets are to be made in large sizes, weighing 2 pounds 8 ounces each. It is estimated that the machine would have a capacity of 9 tons per hour. It is anticipated that the plant will be in operation during 1908, manufacturing briquets intended for household purposes and for stationary boilers.

*Washington Coal Briquetting Company, Seattle, Wash.*—This company was incorporated in 1907 for the briquetting of slack coals from the coal mines of the State. The plant had not been completed at the close of 1907.

*The Coal-Briquette Machine Company, Oshkosh, Wis.*—This company organized in 1907 and expected to be in operation during 1908. It is manufacturing some briquets out of anthracite and bituminous coal and lignite in an experimental way. The briquets are cylindrical in shape and weigh, approximately, 12 ounces each. The capacity of the machine is rated at 48 tons a day.

*American Lignite Briquette Company, Rockdale, Tex.*—This company, of which Mr. J. J. Olsen, of San Antonio, is president, was organized in 1907 for the purpose of briquetting lignite mined at Rockdale. The company expected to be in operation during the summer of 1908.

*United States Coal Manufacturing Company, 1339 Arch street, Philadelphia, Pa.*—This company has manufactured some briquets in an experimental manner, but at the close of 1907 had not produced any on a commercial scale. The briquets are of triangular shape, of small size, and intended for domestic use. The character of the binder and the proportion of binder and coal used are kept secret by the company. High calorific value, easy ignition, complete combustion, and absence of clinkering are merits claimed for these briquets.

*R. B. Metcalf, Portsmouth, R. I.*—Mr. Metcalf, who has done considerable experimental work in the briquetting of Rhode Island anthracite, had not begun the manufacturing of briquets on a commercial scale at the close of 1907, although he expected to have a plant in operation before the close of 1908.

## RECENT LITERATURE.

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# COKE.

By **Edward W. Parker.**

## INTRODUCTION.

In the present chapter, as in the preceding ones of the series, the use of the word "coke" is limited to that product which is obtained by the distillation or partial combustion of bituminous coal in retorts or ovens, and which is generally known as "oven coke," suitable for furnace and foundry use. Ordinary gas-house coke obtained as a by-product in the manufacture of illuminating gas is not considered as coming within the scope of this report. Owing, however, to certain changes which have taken place in the last few years, it is not possible to confine the term coke to that which is used exclusively for furnace or foundry purposes. A not unimportant industry which has developed within the last few years is the preparation of coke for domestic use and for other purposes where smokeless fuel is desired, and this has made it necessary to include in these reports some coke which is not manufactured for strictly metallurgical purposes. The same ovens produce coke which is used for metallurgical and domestic purposes—in fact, one part of the same charge may go to the foundries and furnaces, and another part be crushed and sized for household use. Under such conditions it is manifestly impossible to make a separation of the coke for metallurgical use and to limit the scope of this report to that particular product. In the earlier volumes of this series the only coke considered was that made in ovens most of which, as at the present time, were of the beehive type, and the product was used almost entirely for metallurgical purposes. With the development of the retort ovens which began in 1893, a new feature was added to the industry. In such cases coke is sometimes the primary product and is a strictly metallurgical fuel. In other cases gas, either for illuminating or fuel purposes, is the primary product and coke becomes the secondary product, some of it being used in metallurgical establishments while some goes into other manufacturing, railroad, or domestic trade. Whether the coke is a primary or secondary product is determined by the location of the plant and the demands of the particular locality. In a subsequent table a detailed list of the by-product retort coke oven plants in the United States is given, with a statement regarding the purposes for which the coke and the gas are used.

From 1893, when the first plant of 12 by-product ovens was completed by the Semet-Solvay Company, of Syracuse, N. Y., to the close of 1904, there was a steady and noteworthy increase in the construction of retort or by-product ovens in the United States. During the last three years, however, there has been a decided falling off in the number of new ovens built or contracted for. On December 31, 1903, there were 1,335 by-product ovens in course of construction; in 1904 there were 832; in December, 1905, the amount of new work under construction was represented by 417 ovens building; and on December 31, 1906, the number of new ovens in course of construction had fallen to 112. On December 31, 1907, there were 330 new retort ovens under construction, 280 of which were in Illinois and 50 in Ohio. When the enormous waste which attends the manufacture of coke in beehive ovens is considered, the relatively slow development of the retort oven industry in the United States is difficult to understand. The value of the by-products (gas, tar, and ammonia) in the manufacture of coke in retort ovens in the United States in 1907 was $7,548,071, obtained from the distillation of 7,506,174 tons of coal. The quantity of coal made into coke in beehive ovens in 1907 was 54,485,522 tons. At the same ratio the value of the gas, tar, and ammonia, which were wasted in the beehive oven practice in 1907, would have amounted to over $55,000,000. (See section on by-product coke making on a subsequent page.) The coke product of the retort ovens is in most cases a high-grade metallurgical fuel, and is primarily intended for such use, although the coke itself is not in all cases a primary product. In some instances the coke is a secondary product, but can not be considered a by-product like gas-house coke.

The coal consumed in the manufacture of coke in the United States is drawn from the following bituminous regions or fields:

1. The Appalachian region, embracing the great coking coal fields of Pennsylvania, Virginia, West Virginia, Ohio, eastern Kentucky, Tennessee, Alabama, and Georgia.
2. The Eastern Interior region, which includes the coal fields of Illinois, Indiana, and western Kentucky.
3. The Western Interior region, embracing the States of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Arkansas.
4. The Rocky Mountain regions, contained within the States of Colorado, New Mexico, Utah, Montana, and Wyoming.
5. The Pacific Coast regions, in which the only coking coals are found in the State of Washington.

The coal of the northern interior region lying wholly within the State of Michigan has not been used in the manufacture of coke. A considerable quantity of coke is made in States in which there are no coal fields, i. e., Massachusetts, Minnesota, New York, New Jersey, and Wisconsin. The ovens near Baltimore, Md., and at Delray and Wyandotte, Mich., are supplied with coal from other States. One of the two plants in Wisconsin is composed of beehive ovens in which coal drawn from the mines of Pennsylvania is used. This is the only beehive plant in operation outside of the coal producing States. All of the other coking establishments outside of the States producing coking coal are retort oven plants.

The unit of measurement used in this chapter is uniformly the short ton of 2,000 pounds.

## PRODUCTION.

Including the output from by-product retort coke ovens, the total production of coke in the United States in 1907 amounted to 40,779,564 short tons, valued at $111,539,126, against 36,401,217 short tons, valued at $91,608,034 in 1906. The production in 1907, as in 1906 and in 1905, passed all previous records in the history of coke making in the United States. The increase in 1907 over 1906 was 4,378,347 tons, or 12.02 per cent in quantity, and of $19,931,092, or 21.76 per cent in value. The average price per ton at the ovens advanced from $2.52 in 1906 to $2.74 in 1907. This average price in 1907 is the highest reported in the 28 years that the statistics have been compiled by the Geological Survey.

Of the total production in 1907, 35,171,665 short tons, or 86.25 per cent, was produced in beehive ovens, against 31,843,090 tons of beehive coke in 1906. The production from retort or by-product ovens in 1907 was 5,607,899 short tons, or 13.75 per cent of the total, against 4,558,127 short tons, or 12.52 per cent of the total, in 1906. The increase of beehive coke in 1907 over 1906 was 3,328,575 tons, while the retort oven product shows an increase of 1,049,772 tons. From this it appears that, while the production of beehive coke increased 10.45 per cent, that of retort oven coke increased 23.03 per cent. It also appears that 23.98 per cent of the total increase in 1907 was in by-product ovens. The total production of coke in 1907 was nearly double that of 1900 and more than three times that of 1897. The production in 1907, with the larger proportionate increase in value, was all made during the first nine months of the year, and was due to the continued extraordinary demand in the iron and steel trade which prevailed until the financial flurry unsettled conditions in October. With the coming of the panic there was a prompt and extensive shutting down of blast furnaces and of rolling mills, and this naturally resulted in a general depression throughout the coking regions, but this falling off in the latter part of the year was not enough to entirely overcome the effects of the activity which prevailed from January to October. As shown in a subsequent table, the average prices for both furnace and foundry cokes ranged much above the average for previous years, and the general average for the year exceeded by 11 cents the previously maximum rate obtained in 1903, which resulted from the abnormal conditions produced by the strike in the anthracite regions of Pennsylvania.

In considering the total value and the average selling price for the coke produced in the United States it should be remembered that in many cases the values are arbitrarily fixed. A considerable number of the coke ovens in this country are operated by large corporations which operate also coal mines and blast furnaces, the coke making being really only an incidental part of the business. In such cases the coke product is sometimes charged against the furnace department at cost and sometimes at a figure based upon the cost of coal mining and coke making, plus a percentage of profit on these operations. The value is not fixed by the market price. In other cases the value is estimated upon the average prices for coke of a similar quality produced and sold in the immediate vicinity. These conditions, however, continue from year to year and do not affect comparisons.

The quantity of coal consumed in the manufacture of coke in 1907 was 61,946,109 short tons, valued at $72,784,851. The value of the coke produced from this coal was $111,539,126, a difference of $38,754,275, which represents the profits on the coking operations less the cost of manufacturing and the expenses of administration and selling. In 1906 the value of the coal used was $62,232,524, and the value of the coke produced was $91,608,034, a difference to cover all expenses of manufacture, administration, and profits of $29,375,510.

Following a year of unprecedented activity in the coking regions 1907 opened with a heavy demand for coke and with prices exceptionally good. During February there was some interference with the shipments due to the weather, and while this hampered trade in some respects, it resulted also in some cases in even higher prices for the coke which the producers were able to deliver. The first few months of the year were marked by a considerable advance in wages, and there was also some advance in freight rates, which added to the cost of coke to the consumer. Notwithstanding the unprecedented production, the general railroad situation, particularly so far as the car supply was concerned, was greatly improved over preceding years. Generally satisfactory conditions continued until the latter part of May, when there was a slight falling off in the production and shipments, but there was not the usual summer slump in the market, the coke trade during the warm months being unusually firm for that period of the year. By the middle of August considerable strength had developed, and this continued until the latter part of October, when the effects of the money troubles were shown in a sharp decline in the demand and in the production. So marked was the decline that Connellsville furnace coke, which in the first part of the year had been selling for from $3.50 to $3.75 per short ton, sold for from $2 to $2.50 in November and December, while foundry coke, which had ranged from $4 to $4.50 the first part of the year, sold for $2.50 to $2.75 at the close.

There were at the close of 1907, 99,680 coke ovens in the United States, against 93,901 in 1906, an increase of 5,779. Of the total ovens in existence in 1907, 4,934 were idle during the entire year, leaving 94,746 active ovens which produced 40,779,564 short tons of coke, an average of 430.4 fons per oven. In 1906 out of the 93,901 coke ovens 5,305 were idle, so that in addition to the new ovens added to the equipment in 1907, the number of ovens idle was 371 less than in 1906. The 88,596 active ovens in 1906 produced 36,401,217 tons of coke, an average of 410.9 short tons per oven. The idle beehive ovens in 1907, as in 1906, were with but few exceptions plants which had not been operated for several years, and which have been practically abandoned. The idle number in 1907 included 81 retort ovens, of which 56 was the bank of Newton-Chambers ovens at Pocahontas, Va. These ovens have not been operated to any extent since their installation several years ago. The total number of by-product recovery ovens in existence at the close of 1907 was 3,892, of which as stated, 81 were idle during the year. The production of 5,607,899 tons of retort oven coke was therefore obtained from 3,811 active ovens. The average production from the retort ovens was accordingly 1,472 tons. The total number of active beehive ovens in 1907 was 90,935, and the total production of beehive coke was 35,171,665 short tons, making an average of 386.8 tons of coke per oven, as against 1,472 tons as the average production for each retort oven. The average production from each beehive oven has increased from 365.8 in 1905 to 373.6 in 1906, and to 386.8 in 1907, while the average production for the retort ovens increased from 1,158.8 tons in 1905 to 1,356 tons in 1906, and to 1,472 tons in 1907. In 1905 the average production from by-product ovens was a little more than three times that of the beehive, while in 1907 it was nearly four times as great.

At the close of 1907 there were 2,546 ovens in course of construction, this being the smallest number reported as in process of construction since 1899. Of the ovens building 330, or nearly 13 per cent, were by-product recovery ovens. Of the 330 retort ovens building 50 were of the United-Otto type at Kokotto, Ohio, and 280 were Koppers regenerative ovens being built at Joliet, Ill., by the Illinois Steel Company.

The number of completed retort ovens has almost doubled in four years, and almost quadrupled in eight years, there being 3,892 ovens in existence at the close of 1907, as compared with 1,956 in 1903, and 1,020 in 1899. The production of by-product coke has increased about four times in five years. In 1902 the production of by-product coke was 1,403,588 tons, or 5.5 per cent of the total; in 1903 it was 1,882,394 tons, or 7.4 per cent of the total; in 1904 it was 2,608,229 tons, or 11 per cent of the total, in 1906 it was 4,558,127 tons, or 12.5 per cent of the total; and in 1907 it was 5,607,899 tons, or 13.75 per cent of the total.

Considering each bank of ovens as a separate establishment, the returns for 1907 show a total of 552 establishments, compared with 532 in 1906, and 519 in 1905. There were 67 idle establishments throughout the year in 1907, compared with 69 in 1906, and 75 in 1905. These 67 idle establishments in 1907 included 16, with a total of 1,872 ovens which were incomplete, or if completed, were not put in blast before the close of the year.

The statistics of the production of coke in 1906 and 1907 are presented by States and Territories in the following tables:

*Manufacture of coke in the United States, by States and Territories, in 1906 and 1907.*

1906.

| State or Territory. | Establishments. | Ovens. | | Coal used (short tons). | Yield of coal in coke (per cent). | Coke produced (short tons). | Total value of coke. | Price of coke per ton. |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| Alabama | 42 | 9,731 | 160 | 5,184,597 | 58.5 | 3,034,501 | $8,477,899 | $2.79 |
| Colorado[a] | 15 | 3,419 | 80 | 2,566,196 | 56.7 | 1,455,905 | 4,504,748 | 3.09 |
| Georgia | 2 | 531 | 0 | 128,052 | 54.9 | 70,280 | 277,921 | 3.95 |
| Illinois | 4 | 309 | 0 | 362,163 | 74.2 | 268,693 | 1,205,462 | 4.48 |
| Indiana | 1 | 48 | 0 | ........ | ........ | ........ | ........ | ........ |
| Indian Territory | 5 | 490 | 0 | 95,296 | 52.2 | 49,782 | 204,205 | 4.10 |
| Kansas | 5 | 81 | 0 | 2,807 | 60.5 | 1,698 | 4,101 | 2.42 |
| Kentucky | 6 | 462 | 0 | 148,448 | 49.9 | 74,064 | 169,846 | 2.29 |
| Missouri | 2 | 6 | 0 | 0 | ........ | 0 | 0 | ........ |
| Montana | 4 | 555 | 100 | 69,045 | 55.3 | 38,182 | 266,024 | 6.97 |
| New Mexico | 4 | 571 | 450 | 261,609 | 56.5 | 147,747 | 442,712 | 3.00 |
| Ohio | 8 | 575 | 0 | 437,567 | 67.2 | 293,994 | 1,013,248 | 3.45 |
| Pennsylvania | 239 | 47,185 | 2,373 | 34,503,513 | 66.8 | 23,060,511 | 54,184,531 | 2.35 |
| Tennessee | 17 | 2,731 | 138 | 929,405 | 52 | 483,428 | 1,350,856 | 2.79 |
| Utah | 2 | 684 | 170 | (b) | ........ | (b) | (b) | ........ |
| Virginia | 18 | 4,641 | 695 | 2,296,227 | 68.7 | 1,577,659 | 3,611,659 | 2.29 |
| Washington | 5 | 216 | 0 | 76,896 | 59.4 | 45,642 | 226,977 | 4.97 |
| West Virginia | 141 | 19,714 | 353 | 5,822,619 | 63.8 | 3,713,514 | 8,192,956 | 2.21 |
| Maryland<br>Massachusetts<br>Michigan<br>Minnesota<br>New Jersey<br>New York<br>Wisconsin<br>Wyoming | 12 | 1,952 | 0 | 2,861,934 | 72.9 | 2,085,617 | 7,474,889 | 3.58 |
| Total | 532 | 93,901 | 4,519 | 55,746,374 | 65.3 | 36,401,217 | 91,608,034 | 2.52 |

[a] Includes the production of Utah.

[b] Included with Colorado.

*Manufacture of coke in the United States, by States and Territories, in 1906 and 1907*—Con.

**1907.**

| State or Territory. | Establishments. | Ovens. | | Coal used (short tons). | Yield of coal in coke (per cent). | Coke produced (short tons). | Total value of coke. | Price of coke per ton. |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| Alabama | 43 | 9,889 | 50 | 4,973,296 | 61.0 | 3,021,794 | $9,216,194 | $3.05 |
| Colorado [a] | 16 | 3,799 | 50 | 2,388,911 | 59.5 | 1,421,579 | 4,747,436 | 3.34 |
| Georgia | 2 | 350 | 0 | 136,031 | 55.1 | 74,934 | 315,371 | 4.21 |
| Illinois | 5 | 309 | 280 | 514,983 | 72.3 | 372,697 | 1,737,464 | 4.66 |
| Indiana | 1 | 28 | 0 | 0 | ...... | 0 | 0 | ...... |
| Kansas | 6 | 83 | 0 | 11,392 | 55.0 | 6,274 | 19,837 | 3.16 |
| Kentucky | 6 | 495 | 0 | 129,538 | 51.7 | 67,068 | 157,288 | 2.35 |
| Missouri | 1 | 5 | 0 | 0 | ...... | 0 | 0 | ...... |
| Montana | 5 | 567 | 15 | 68,948 | 59.0 | 40,714 | 295,174 | 7.25 |
| New Mexico | 4 | 896 | 125 | 446,140 | 59.4 | 265,125 | 840,253 | 3.17 |
| Ohio | 8 | 600 | 50 | 376,759 | 71.8 | 270,634 | 819,262 | 3.03 |
| Oklahoma (Indian Territory) | 5 | 490 | 50 | 38,615 | 49.4 | 19,089 | 82,447 | 4.32 |
| Pennsylvania | 253 | 51,364 | 1,337 | 39,733,177 | 66.7 | 26,513,214 | 67 638,024 | 2.55 |
| Tennessee | 18 | 2,806 | 80 | 825,221 | 56.6 | 467,499 | 1,592,225 | 3.41 |
| Utah | 2 | 884 | 0 | (b) | ...... | (b) | (b) | ...... |
| Virginia | 19 | 5,333 | 50 | 2,264,720 | 68.2 | 1,545,280 | 3,765,733 | 2.44 |
| Washington | 5 | 216 | 0 | 85,860 | 60.6 | 52,028 | 293,019 | 5.63 |
| West Virginia | 142 | 19,688 | 459 | 6,536,795 | 62.9 | 4,112,896 | 9,717,130 | 2.36 |
| Maryland | 11 | 1,878 | 0 | 3,415,723 | 74.0 | 2,528,739 | 10,302,269 | 4.07 |
| Massachusetts | | | | | | | | |
| Michigan | | | | | | | | |
| Minnesota | | | | | | | | |
| New Jersey | | | | | | | | |
| New York | | | | | | | | |
| Wisconsin | | | | | | | | |
| Total | 552 | 99,680 | 2,546 | 61,946,109 | 65.8 | 40,779,564 | 111,539,126 | 2.74 |

[a] Includes the production of Utah.

[b] Production included with Colorado.

There were 23 States and Territories in which coke was produced in 1907, a decrease of 1 as compared with 1906. Wyoming, which reported a production of coke in 1906, did not make any in 1907. In addition to this there were 8 other States in which the production in 1907 shows a decrease as compared with 1906. These 8 States in which the production decreased were Alabama, Colorado, Kentucky, Maryland, Ohio, Oklahoma, Tennessee, and Virginia, 6 of them being east and 2 west of the Mississippi River. The total decreases amounted to 156,390 tons. The increase in the other 15 States amounted to 4,534,737 tons, making a net increase for the United States of 4,378,347 short tons. The production from by-product ovens increased from 4,558,127 tons to 5,607,899 tons, a gain of 1,049,772 tons, or 23.03 per cent. The production of beehive ovens increased from 31,843,090 tons in 1906 to 35,171,665 tons in 1907, a gain of 3,328,575 tons, or 10.45 per cent. The most notable increase was in Pennsylvania, whose production showed a gain of 3,452,703 tons, or 14.97 per cent. West Virginia's production increased 399,382 tons, or 10.75 per cent. New Mexico's production increased 79.45 per cent, but the gain in tonnage was only 117,378 tons. The production of Illinois was largely increased by the operations of the by-product oven plant at South Chicago, this State showing an increase of 104,004 tons, or 38.71 per cent. In 1905 the State of Illinois produced only 10,307 tons of coke. In 1907 Illinois produced 372,697 tons.

The combined production of Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, and Wisconsin, nearly all of which is the output of by-product ovens, showed an increase of 443.122 tons, or 21.25 per cent.

The increases and decreases in the several States in 1907, as compared with 1906, are shown in the following table:

*Increase and decrease in coke production, by States and Territories, in 1907, as compared with 1906 (in short tons).*

| State or Territory. | Total quantity. |  | Increase. |  | Decrease. |  |
|---|---|---|---|---|---|---|
|  | 1907. | 1906. | Quantity. | Percentage. | Quantity. | Percentage. |
| Alabama | 3,021,794 | 3,034,501 |  |  | 12,707 | 0.41 |
| Colorado [a] | 1,421,579 | 1,455,905 |  |  | 34,326 | 2.36 |
| Georgia | 74,934 | 70,280 | 4,654 | 6.62 |  |  |
| Illinois | 372,697 | 268,693 | 104,004 | 38.71 |  |  |
| Kansas | 6,274 | 1,698 | 4,576 | 269.49 |  |  |
| Kentucky | 67,068 | 74,064 |  |  | 6,996 | 9.45 |
| Montana | 40,714 | 38,182 | 2,532 | 6.63 |  |  |
| New Mexico | 265,125 | 147,747 | 117,378 | 79.45 |  |  |
| Ohio | 270,634 | 293,994 |  |  | 23,360 | 7.91 |
| Oklahoma (Indian Territory) | 19,089 | [c] 49,782 |  |  | 30,693 | 61.65 |
| Pennsylvania | 26,513,214 | 23,060,511 | 3,452,703 | 14.97 |  |  |
| Tennessee | 467,499 | 483,428 |  |  | 15,929 | 3.30 |
| Virginia | 1,545,280 | 1,577,659 |  |  | 32,379 | 2.05 |
| Washington | 52,028 | 45,642 | 6,386 | 13.99 |  |  |
| West Virginia | 4,112,896 | 3,713,514 | 399,382 | 10.75 |  |  |
| Maryland | 2,528,739 | 2,085,617 | 443,122 | 21.25 |  |  |
| Massachusetts |  |  |  |  |  |  |
| Michigan |  |  |  |  |  |  |
| Minnesota |  |  |  |  |  |  |
| New Jersey |  |  |  |  |  |  |
| New York |  |  |  |  |  |  |
| Wisconsin |  |  |  |  |  |  |
| Wyoming [b] |  |  |  |  |  |  |
| Total | 40,779,564 | 36,401,217 | 4,378,347 | 12.02 |  |  |

[a] Includes Utah. [b] Not included in 1907 figures. [c] Figures for Indian Territory.

## PRODUCTION IN PREVIOUS YEARS.

The earliest record of coke production in the United States is that contained in the census report for 1880. In that year the total production of coke amounted to 3,338,300 short tons. Five years prior to that date, according to statistics compiled by the American Iron and Steel Association, the use of coke in iron furnaces exceeded that of anthracite coal. The same authority states that prior to 1855 most of the iron made in this country was made with charcoal. In that year anthracite took the lead and maintained it until passed by coke in 1875. Six years earlier coke had taken the lead over charcoal. Now very little iron is made with anthracite, and charcoal is used only for making special brands of pig iron. A comprehensive idea of the growth of the coking industry in the United States is obtained by dividing the history of the last twenty years into five-year periods. The average production for the three years prior to 1880 to 1882 was about 4,000,000 tons a year. In the five years from 1883 to 1887, inclusive, the average production amounted to 5,980,459 short tons. The average for the next five years, from 1888 to 1892, was nearly double that of the preceding five years, amounting to 10,533,918 tons. This period was followed by the panic years of 1893, 1894, and 1895, and the coke production showed only a small increase in the next five years, averaging during that time 11,418,536 tons per year. The return of prosperous conditions, which began in 1896, has shown no decided setback since that time, and the production of coke during the five years from 1898 to 1902, inclusive, attained an average of 20,689,347 tons, and exceeded for the first time a total of 25,000,000 tons in 1902. The average production for the last five years was 36,749,805 tons, an increase of nearly 80 per cent over the preceding 5 years.

In the following table are given the statistics of the manufacture of coke in the years 1880 and 1890 and from 1900 to 1907, inclusive:

*Statistics of the manufacture of coke in the United States in 1880, 1890, and 1900–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Percentage yield of coal in coke. |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 186 | 12,372 | 1,150 | 5,237,741 | 3,338,300 | $6,631,267 | $1.99 | 63.0 |
| 1890 | 253 | 37,158 | 1,547 | 18,005,209 | 11,508,021 | 23,215,302 | 2.02 | 64.0 |
| 1900 | 396 | 58,484 | 5,804 | 32,113,553 | 20,533,348 | 47,443,331 | 2.31 | 63.9 |
| 1901 | 423 | 63,951 | 5,205 | 34,207,965 | 21,795,883 | 44,445,923 | 2.039 | 63.7 |
| 1902 | 456 | 69,069 | 8,758 | 39,604,007 | 25,401,730 | 63,339,167 | 2.49 | 64.1 |
| 1903 | 500 | 79,334 | 6,175 | 39,423,525 | 25,274,281 | 66,498,664 | 2.63 | 64.1 |
| 1904 | 507 | 83,599 | 4,430 | 36,531,608 | 23,661,106 | 46,144,941 | 1.95 | 64.8 |
| 1905 | 519 | 87,564 | 4,751 | 49,530,677 | 32,231,129 | 72,476,196 | 2.25 | 65.1 |
| 1906 | 532 | 93,901 | 4,519 | 55,746,374 | 36,401,217 | 91,608,034 | 2.52 | 65.3 |
| 1907 | 552 | 99,680 | 2,546 | 61,946,109 | 40,779,564 | 111,539,126 | 2.74 | 65.8 |

The statistics of the production of coke in each State and Territory for the last five years, and the total annual production since 1880, are shown in the following tables. During the twenty-eight years covered by these reports there have been seven in which the production decreased as compared with the preceding year. The most notable decreases were in 1893 and 1894, and were due to the panic and depression which made those years memorable in our recent industrial history. The temporary boom of 1895 was followed by another period of depression in 1896, which was also reflected in a decreased coke production. The slight decrease of 1904 was due to a natural reaction from the abnormal production of the two preceding years, aided by the unsettled conditions of a Presidential year and a slump in the iron trade, which occurred during the summer months.

*Quantity of coke produced in the United States, 1903–1907, by States and Territories, in short tons.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | 2,693,497 | 2,340,219 | 2,576,986 | 3,034,501 | 3,021,794 |
| Colorado[a] | 1,053,840 | 789,060 | 1,378,824 | 1,455,905 | 1,421,579 |
| Georgia | 85,546 | 75,812 | 70,593 | 70,280 | 74,934 |
| Illinois | ........ | 4,439 | 10,307 | 268,693 | 372,697 |
| Kansas | 14,194 | 9,460 | 4,425 | 1,698 | 6,274 |
| Kentucky | 115,362 | 64,112 | 79,487 | 74,064 | 67,068 |
| Missouri | 1,839 | 2,446 | 1,580 | ........ | ........ |
| Montana | 45,107 | 41,497 | 31,482 | 38,182 | 40,714 |
| New Mexico | 11,050 | 58,250 | 89,638 | 147,747 | 265,125 |
| Ohio | 143,913 | 109,284 | 277,130 | 293,994 | 270,634 |
| Oklahoma (Indian Territory) | 49,818 | 44,808 | 54,781 | 49,782 | 19,089 |
| Pennsylvania | 15,650,932 | 14,861,064 | 20,573,736 | 23,060,511 | 26,513,214 |
| Tennessee | 546,875 | 379,240 | 468,092 | 483,428 | 467,499 |
| Utah | (b) | (b) | (b) | (b) | (b) |
| Virginia | 1,176,439 | 1,101,716 | 1,499,481 | 1,577,659 | 1,545,280 |
| Washington | 45,623 | 45,432 | 53,137 | 45,642 | 52,028 |
| West Virginia | 2,707,818 | 2,283,086 | 3,400,593 | 3,713,514 | 4,112,896 |
| Maryland<br>Massachusetts<br>Michigan<br>Minnesota<br>New Jersey<br>New York<br>Wisconsin<br>Wyoming[c] | 932,428 | 1,451,172 | 1,660,857 | 2,085,617 | 2,528,739 |
| Total | 25,274,281 | 23,661,106 | 32,231,129 | 36,401,217 | 40,779,564 |

[a] Colorado includes Utah. [b] Included with Colorado. [c] Not included in 1907 figures.

*Quantity of coke produced in the United States, 1880–1907, in short tons.*

| | | | | | |
|---|---|---|---|---|---|
| 1880 | 3, 338, 300 | 1890 | 11, 508, 021 | 1900 | 20, 533, 348 |
| 1881 | 4, 113, 760 | 1891 | 10, 352, 688 | 1901 | 21, 795, 883 |
| 1882 | 4, 793, 321 | 1892 | 12, 010, 829 | 1902 | 25, 401, 730 |
| 1883 | 5, 464, 721 | 1893 | 9, 477, 580 | 1903 | 25, 274, 281 |
| 1884 | 4, 873, 805 | 1894 | 9, 203, 632 | 1904 | 23, 661, 106 |
| 1885 | 5, 106, 696 | 1895 | 13, 333, 714 | 1905 | 32, 231, 129 |
| 1886 | 6, 845, 369 | 1896 | 11, 788, 773 | 1906 | 36, 401, 217 |
| 1887 | 7, 611, 705 | 1897 | 13, 288, 984 | 1907 | 40, 779, 564 |
| 1888 | 8, 540, 030 | 1898 | 16, 047, 209 | | |
| 1889 | 10, 258, 022 | 1899 | 19, 668, 569 | | |

## VALUE OF COKE PRODUCED.

In the following tables are presented statements showing the value of the coke produced in each State and Territory during the last five years and the total value of the coke product of the United States each year since 1880. The effects on the coke trade of the fuel famine caused by the strike in the anthracite region of Pennsylvania are shown by the greatly enhanced values of the coke produced in 1902 and 1903. The extraordinary production in 1905, however, coupled with the high range of prices which obtained during the year, brought the total value up to an amount exceeding by nearly $6,000,000 the previous high-water mark of 1903.

The continued activity and expansion of the iron and steel industries through 1906, added to the scarcity of fuel brought about by the suspension of coal-mining operations on April 1, resulted in a still further advance in prices during 1906 and an increase of $19,131,838 over the high record made in 1905. Throughout the greater part of 1907 the demand from the iron and steel industries continued without abatement, and the production of coke for the first nine months was practically up to oven capacity. The highest prices in the history of the industry were obtained, and the total value shows a further increase over 1906 of $19,931,092.

*Total value, at the ovens, of the coke made in the United States, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | $7, 622, 528 | $5, 716, 413 | $7, 646, 957 | $8, 477, 899 | $9, 216, 194 |
| Colorado | [a] 3, 089, 783 | [a] 2, 590, 251 | [a] 4, 157, 517 | [a] 4, 504, 748 | 4, 747, 436 |
| Georgia | 368, 351 | 212, 697 | 224, 260 | 277, 921 | 315, 371 |
| Illinois | ........ | 9, 933 | 27, 681 | 1, 205, 462 | 1, 737, 464 |
| Kansas | 50, 221 | 23, 485 | 13, 818 | 4, 101 | 19, 837 |
| Kentucky | 305, 327 | 138, 226 | 159, 659 | 169, 846 | 157, 288 |
| Missouri | 5, 797 | 6, 115 | 4, 072 | ........ | ........ |
| Montana | 310, 882 | 280, 745 | 211, 351 | 266, 024 | 295, 174 |
| New Mexico | 31, 539 | 171, 976 | 253, 229 | 442, 712 | 840, 253 |
| Ohio | 528, 142 | 337, 606 | 970, 897 | 1, 013, 248 | 819, 262 |
| Oklahoma (Indian Territory) | 227, 542 | 209, 165 | 199, 424 | 204, 205 | 82, 447 |
| Pennsylvania | 38, 969, 101 | 25, 027, 462 | 42, 253, 178 | 54, 184, 531 | 67, 638, 024 |
| Tennessee | 1, 706, 722 | 905, 540 | 1, 184, 442 | 1, 350, 856 | 1, 592, 225 |
| Utah | (b) | (b) | (b) | (b) | (b) |
| Virginia | 2, 724, 047 | 1, 772, 717 | 2, 869, 452 | 3, 611, 659 | 3, 765, 733 |
| Washington | 214, 776 | 207, 357 | 251, 717 | 226, 977 | 293, 019 |
| West Virginia | 7, 115, 842 | 3, 757, 850 | 6, 548, 205 | 8, 192, 956 | 9, 717, 130 |
| Maryland | 3, 228, 064 | 4, 777, 403 | 5, 500, 337 | 7, 474, 889 | 10, 302, 269 |
| Massachusetts | | | | | |
| Michigan | | | | | |
| New Jersey | | | | | |
| New York | | | | | |
| Wisconsin | | | | | |
| Wyoming [c] | | | | | |
| Total | 66, 498, 664 | 46, 144, 941 | 72, 476, 196 | 91, 608, 034 | 111, 539, 126 |

[a] Includes value of Utah coke.
[b] Included with Colorado.
[c] Not included in 1907 figures.

*Total value, at the ovens, of the coke made in the United States, 1880–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1880 | $6, 631, 265 | 1890 | $23, 215, 302 | 1900 | $47, 443, 331 |
| 1881 | 7, 725, 175 | 1891 | 20, 393, 216 | 1901 | 44, 445, 923 |
| 1882 | 8, 462, 167 | 1892 | 23, 536, 141 | 1902 | 63, 339, 167 |
| 1883 | 8, 121, 607 | 1893 | 16, 523, 714 | 1903 | 66, 498, 664 |
| 1884 | 7, 242, 878 | 1894 | 12, 328, 856 | 1904 | 46, 144, 941 |
| 1885 | 7, 629, 118 | 1895 | 19, 234, 319 | 1905 | 72, 476, 196 |
| 1886 | 11, 153, 366 | 1896 | 21, 660, 729 | 1906 | 91, 608, 034 |
| 1887 | 15, 321, 116 | 1897 | 22, 102, 514 | 1907 | 111, 539, 126 |
| 1888 | 12, 445, 963 | 1898 | 25, 586, 699 | | |
| 1889 | 16, 630, 301 | 1899 | 34, 670, 417 | | |

From the preceding statements, showing the quantity and value of the coke produced in a series of years, the following tables have been prepared. These show the average price per ton obtained for the coke product in each State and Territory for the last five years and the average price of the total product since 1880. These average prices are obtained by dividing the total value by the total quantity of coke produced or sold. Although the figures may be accepted as indicating the general tendency of prices, they do not always represent the actual selling value of the coke, as has already been shown. Some of the largest producers of coke consume their entire product in their own blast furnaces. In some such cases the value of the coke is given at the actual cost of production; in others it is based upon the cost of production, adding a percentage of profit on the coking operations; and in still other cases the values are based upon the marketed product of a similar quality of coke in the immediate vicinity. These conditions, however, continue without material change from year to year, so that the prices as given may be generally accepted as indicating the general condition of the market.

As will be seen from the following table, the average price obtained in 1907 was the highest recorded in the twenty-eight years covered by this series of reports. The highest average price previously recorded was in 1903, when, because of abnormal conditions produced by a strike in the anthracite region, the price of coke was advanced 14 cents over the previous high-water mark of 1902. The slump in the iron trade during the summer of 1904 reacted on the coking industry so that the output was reduced and values were totally demoralized, and the average price for the year was the lowest since 1899. This setback, however, was temporary, and the average prices have advanced from $2.25 in 1905 to $2.52 in 1906 and to $2.74 in 1907. It may be confidently stated that 1907 was the most profitable in the history of the coking industry. It may be noted that whereas the average price of bituminous coal made into coke has increased from $1.02 in 1905 to $1.18 in 1907, an advance of 16 cents, or 16 per cent, the price of coke has advanced from $2.25 per ton to $2.74 per ton, an increase of 49 cents, or 22 per cent.

The average prices of coke, by States, from 1902 to 1907, inclusive, and for the United States from 1880 to 1907 are shown in the following tables:

*Average price per short ton, at the ovens, of the coke made in the United States, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | $2.83 | $2.44 | $2.97 | $2.79 | $3.05 |
| Colorado [a] | 2.93 | 3.28 | 3.02 | 3.09 | 3.34 |
| Georgia | 4.31 | 2.81 | 3.18 | 3.95 | 4.21 |
| Illinois | ........ | 2.24 | 2.69 | 4.48 | 4.66 |
| Kansas | 3.54 | 2.48 | 3.12 | 2.42 | 3.16 |
| Kentucky | 2.65 | 2.15 | 2.01 | 2.29 | 2.35 |
| Missouri | 3.15 | 2.50 | 2.58 | ........ | ........ |
| Montana | 6.89 | 6.77 | 6.71 | 6.97 | 7.25 |
| New Mexico | 2.85 | 2.95 | 2.83 | 3.00 | 3.17 |
| Ohio | 3.67 | 3.09 | 3.50 | 3.45 | 3.03 |
| Oklahoma (Indian Territory) | 4.57 | 4.67 | 3.64 | 4.10 | 4.32 |
| Pennsylvania | 2.49 | 1.68 | 2.05 | 2.35 | 2.55 |
| Tennessee | 3.12 | 2.39 | 2.53 | 2.79 | 3.41 |
| Utah | (b) | (b) | (b) | (b) | (b) |
| Virginia | 2.32 | 1.61 | 1.91 | 2.29 | 2.44 |
| Washington | 4.71 | 4.56 | 4.74 | 4.97 | 5.63 |
| West Virginia | 2.63 | 1.65 | 1.92 | 2.21 | 2.36 |
| Maryland<br>Massachusetts<br>Michigan<br>New Jersey<br>New York<br>Wisconsin<br>Wyoming [c] | 3.46 | 3.29 | 3.31 | 3.58 | 4.07 |
| Average | 2.63 | 1.95 | 2.25 | 2.52 | 2.74 |

[a] Includes Utah. [b] Included with Colorado. [c] Not included in 1907 figures.

*Average price per short ton, at the ovens, of the coke made in the United States, 1880–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1880 | $1.99 | 1890 | $2.02 | 1900 | $2.31 |
| 1881 | 1.88 | 1891 | 1.97 | 1901 | 2.04 |
| 1882 | 1.77 | 1892 | 1.96 | 1902 | 2.49 |
| 1883 | 1.49 | 1893 | 1.74 | 1903 | 2.63 |
| 1884 | 1.49 | 1894 | 1.34 | 1904 | 1.95 |
| 1885 | 1.49 | 1895 | 1.44 | 1905 | 2.25 |
| 1886 | 1.63 | 1896 | 1.84 | 1906 | 2.52 |
| 1887 | 2.01 | 1897 | 1.66 | 1907 | 2.74 |
| 1888 | 1.46 | 1898 | 1.59 | | |
| 1889 | 1.62 | 1899 | 1.76 | | |

## NUMBER OF COKE WORKS IN THE UNITED STATES.

Considering each bank of ovens as a separate establishment, there were, at the close of 1907, 552 establishments manufacturing coke in the United States, an increase of 20 as compared with 1906. These 552 establishments included 16 with a total of 1,872 ovens which were not completed or had not been put in blast during the year, and consequently did not contribute to the production. The ovens of these 16 establishments which had been completed but were not in blast are included in the idle ovens previously mentioned. The incompleted ovens are not considered as idle. In 1906 there were 15 establishments with a total of 1,887 ovens which had not been completed or put in blast during that year. In addition to the 16 new plants that were not operated there were 51 other establishments with a total of 4,614 ovens which were idle throughout 1907. Of these 51 idle establishments 17, or exactly one-third, with a total of 843 ovens, were in the Monongahela River district of West Virginia. Nearly all of the older banks of ovens which were idle during 1907 were comparatively small ones, having an average of 90 ovens each. The majority of them have been idle for several years and some of them have been practically abandoned. There were, however, only 3 establishments with a total of 161 ovens reported as permanently abandoned in 1907. Deducting the idle plants and those not completed before the end of the year, a total of 67 establishments, it is found that there were 485 active establishments during 1907 with a total of 94,746 ovens, or an average of 195 ovens to each plant.

The total production from the 485 active establishments in 1907 was 40,779,564 short tons, or an average of 84,082 tons for each plant. In 1906 there were 448 active establishments, the total production from which was 36,401,217 short tons, or an average of 81,253 tons for each bank. In 1905 434 active establishments produced 32,231,129 short tons, or an average of 74,265 tons each. The average output for each plant in 1907 was 3.48 per cent greater than 1906, and 13.22 per cent greater than 1905. In 1880, the first year for which these statistics were collected, there were 186 establishments, with an average production from each of 17,948 tons, indicating that the average output from each plant in 1907 was 4.7 times that of 1880.

It should be stated that the word "establishment" as used in this report is intended to designate the number of separate plants or banks of ovens whether operated or idle and whether reported from one central office or not. Different plants controlled or operated by one company are considered separate establishments.

The total number of establishments manufacturing coke in the United States at the end of each decade from 1850 to 1900, and at the end of each year from 1901 to 1907, inclusive, is shown in the following table. The numbers reported in 1850, 1860, and 1870 are for census years; the others are for calendar years:

*Number of coke establishments in the United States since 1850.*

| | | | | | |
|---|---|---|---|---|---|
| 1850 (census year).... | 4 | 1900, December 31.... | 396 | 1905, December 31.... | 519 |
| 1860 (census year).... | 21 | 1901, December 31.... | 423 | 1906, December 31.... | 532 |
| 1870 (census year).... | 25 | 1902, December 31.... | 456 | 1907, December 31.... | 552 |
| 1880, December 31... | 186 | 1903, December 31.... | 500 | | |
| 1890, December 31... | 253 | 1904, December 31.... | 506 | | |

*Number of coke ovens in the United States.*—In the following table is shown the number of coke ovens in existence in each State and Territory on December 31 for each of the last five years, and at the end of each five years since 1880. The total number of ovens in existence at the close of 1907 (99,680) was 26 per cent more than in 1903, 119 per cent or more than double the number in existence in 1895 and more than eight times the number in existence in 1880.

*Number of coke ovens in each State or Territory at the close of each year, 1903–1907.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | 8,764 | 9,059 | 9,586 | 9,731 | 9,889 |
| Colorado | 3,455 | 3,419 | 3,421 | 3,419 | 3,799 |
| Georgia | 500 | 500 | 533 | 531 | 350 |
| Illinois | 155 | 155 | 275 | 309 | 309 |
| Indiana | 36 | 36 | 36 | 48 | 28 |
| Kansas | 91 | 90 | 91 | 81 | 83 |
| Kentucky | 499 | 499 | 495 | 462 | 495 |
| Maryland | 200 | 200 | 200 | 200 | 200 |
| Massachusetts | 400 | 400 | 400 | 400 | 400 |
| Michigan | 75 | 135 | 135 | 150 | 150 |
| Minnesota | ........ | 50 | 50 | 50 | 50 |
| Missouri | 8 | 8 | 6 | 6 | 5 |
| Montana | 555 | 520 | 555 | 555 | 567 |

*Number of coke ovens in each State or Territory at the close of each year, 1903–1907*—Con.

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| New Jersey | 100 | 100 | 100 | 150 | 150 |
| New Mexico | 126 | 234 | 258 | 571 | 896 |
| New York | 40 | 352 | 399 | 540 | 540 |
| Ohio | 440 | 539 | 573 | 575 | 600 |
| Oklahoma (Indian Territory) | 286 | 286 | 388 | 490 | 490 |
| Pennsylvania | 40,239 | 42,165 | 42,608 | 47,185 | 51,364 |
| Tennessee | 2,439 | 2,436 | 2,615 | 2,731 | 2,806 |
| Utah | 504 | 504 | 504 | 684 | 884 |
| Virginia | 4,251 | 4,345 | 4,549 | 4,641 | 5,333 |
| Washington | 256 | 256 | 216 | 216 | 216 |
| West Virginia | 15,613 | 16,929 | 19,189 | 19,714 | 19,688 |
| Wisconsin | 228 | 308 | 308 | 388 | 388 |
| Wyoming | 74 | 74 | 74 | 74 | 0 |
| Total | 79,334 | 83,599 | 87,564 | 93,901 | 99,680 |

*Number of coke ovens in the United States on December 31 of each fifth year, from 1880 to 1907.*

| | | | |
|---|---|---|---|
| 1880 | 12,372 | 1900 | 58,484 |
| 1885 | 20,116 | 1905 | 87,564 |
| 1890 | 37,158 | 1907 | 99,680 |
| 1895 | 45,565 | | |

A statement of the number of ovens in course of construction at the end of each year since 1902 is shown in the following table. It is not intended to show by this the increase in the number of ovens from year to year, nor does it include the number of new ovens completed during any one year. It merely exhibits the condition of the industry as shown by plants under construction at the close of each year:

*Number of coke ovens building in the United States at the close of each year, 1902–1907.*

| | | | |
|---|---|---|---|
| 1902 | 8,758 | 1905 | 4,751 |
| 1903 | 6,175 | 1906 | 4,519 |
| 1904 | 4,430 | 1907 | 2,546 |

## RANK OF COKE-PRODUCING STATES.

In the following table is shown the relative importance of the different coke-producing States and Territories during the last five years. Pennsylvania, in the manufacture of coke as in the production of coal, has headed the list since these reports have been published. West Virginia and Alabama have for the last twenty-five years been rivals for second place, alternating frequently, and West Virginia has held it three times consecutively, in 1905, 1906, and 1907, the first time in six years that either State has done so. In 1907 West Virginia's production of coke was 36 per cent more than Alabama's, and this practically establishes West Virginia permanently in second place. Virginia and Colorado hold the same relative ranks of fourth and fifth place as they have for the last five years. The most important change noted under the statistics for 1907 is the advance of New York from eighth place in 1906 to sixth place in 1907, this change being due to the operations of the by-product oven plant of the Lackawanna Steel plant at Buffalo. Wisconsin, by reason of the Semet-Solvay ovens at Milwaukee, advanced from thirteenth to seventh place. Tennessee dropped from sixth to eighth place, and Massachusetts from seventh to ninth place. Illinois, because of the production of the Semet-Solvay ovens at South Chicago, advanced from fourteenth to tenth place.

In the 5 leading States, i. e., Pennsylvania, West Virginia, Alabama, Virginia, and Colorado, by far the larger proportion of the coke is made in beehive ovens. In 5 of the next 6 States, i. e., New York, Wisconsin, Massachusetts, Illinois, and Maryland, practically all of the coke is made in by-product ovens.

*Rank of the States and Territories in production of coke, 1903–1907.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Pennsylvania | 1 | 1 | 1 | 1 | 1 |
| West Virginia | 2 | 3 | 2 | 2 | 2. |
| Alabama | 3 | 2 | 3 | 3 | 3 |
| Virginia | 4 | 4 | 4 | 4 | 4 |
| Colorado | 5 | 5 | 5 | 5 | 5 |
| New York | 16 | 11 | 14 | 8 | 6 |
| Wisconsin | 15 | 12 | 12 | 13 | 7 |
| Tennessee | 6 | 7 | 6 | 6 | 8 |
| Massachusetts | 7 | 6 | 7 | 7 | 9 |
| Illinois | 23 | 23 | 22 | 14 | 10 |
| Maryland | 8 | 8 | 8 | 9 | 11 |
| Utah | 9 | 9 | 11 | 10 | 12 |
| Michigan | 11 | 10 | 9 | 11 | 13 |
| Ohio | 10 | 14 | 10 | 12 | 14 |
| New Mexico | 21 | 17 | 15 | 16 | 15 |
| New Jersey | 13 | 13 | 13 | 15 | 16 |
| Minnesota | .......... | 21 | 16 | 17 | 17 |
| Georgia | 14 | 15 | 18 | 19 | 18 |
| Kentucky | 12 | 16 | 17 | 18 | 19 |
| Washington | 18 | 18 | 20 | 21 | 20 |
| Montana | 19 | 20 | 21 | 22 | 21 |
| Oklahoma (Indian Territory) | 17 | 19 | 19 | 20 | 22 |
| Kansas | 20 | 22 | 23 | 23 | 23 |
| Wyoming | 22 | 24 | 24 | 24 | .......... |
| Missouri | 24 | 25 | 25 | .......... | .......... |
| Indiana | 25 | .......... | .......... | .......... | .......... |

## COAL CONSUMED IN THE MANUFACTURE OF COKE.

The determination of the quantity of coal consumed in the manufacture of coke is, to a considerable extent, a matter of estimate, as a large quantity of the coal so used is charged directly into the ovens from the mines without having been previously weighed or measured. The only method of ascertaining the quantity of coal thus used is by the amount paid to the miners for mining, which is based sometimes upon the measured bushel or ton and sometimes by the cubical contents of the mine car, all of which standards are apt to differ materially from that of the weighed ton or bushel. There are comparatively few establishments in this country at which the quantity of coal made into coke is accurately ascertained, though as the industry becomes better organized greater attention is being paid to exactness in this regard, and year by year the quantities as presented in the following tables become more accurate. It is still necessary, however, to estimate a large quantity of the coal consumed in the manufacture of coke.

A considerable quantity of the coal which is not run directly from the mines to the coke ovens is crushed and washed before coking. In some of such cases the weight of this coal before washing is given approximately. In other cases the weight after the slate, pyrite, and other impurities have been removed is reported for the weight of the coal charged into the ovens. In still other instances coke ovens have been constructed chiefly for the purpose of utilizing the slack coal produced, in which cases little or no account is taken of the weight of the coal. It can readily be seen, therefore, that any statement as to the quantity of coal used in the manufacture of coke is necessarily approximate, but as these differences appear from year to year the statistics as collected may be accepted as sufficiently accurate for comparative analysis. As has been stated in previous reports of this series, an apparent discrepancy appears between the statements regarding the quantities of coal consumed in the manufacture of coke as published in the chapter on coal production and those presented herewith. These discrepancies are in general due to the fact that a large quantity of coal is shipped to ovens at a distance from the mine. Where this is the case, the tonnage so shipped would be included in the shipments, the coal statistics showing only the quantity of coal made into coke at the mines.

In 1907 the total quantity of coal made into coke was 61,946,901 short tons, while the quantity of coal reported as made into coke at the mines which is shown in the chapter on the production of coal was 50,289,822 short tons. This indicates that there were 11,657,079 short tons shipped to points distant from the mines before being charged into the ovens.

The quantity of coal used in the manufacture of coke, as obtained for this report, in the several States and Territories, from 1903 to 1907, and the total quantity used for each five years since 1880, are shown in the tables which follow:

*Quantity of coal used in the manufacture of coke in the United States, 1903–1907, by States and Territories, in short tons.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | 4,483,942 | 3,996,578 | 4,409,854 | 5,184,597 | 4,973,296 |
| Colorado [a] | 1,776,974 | 1,376,354 | 2,368,365 | 2,566,196 | 2,388,911 |
| Georgia | 146,086 | 132,270 | 119,036 | 128,052 | 136,031 |
| Illinois | ......... | 8,131 | 16,821 | 362,163 | 514,963 |
| Kansas | 30,503 | 14,525 | 6,504 | 2,807 | 11,392 |
| Kentucky | 247,950 | 140,139 | 154,783 | 148,448 | 129,538 |
| Missouri | 3,004 | 3,815 | 2,551 | 0 | 0 |
| Montana | 82,118 | 78,303 | 68,777 | 69,045 | 68,948 |
| New Mexico | 18,613 | 94,397 | 148,469 | 261,609 | 446,140 |
| Ohio | 211,473 | 165,487 | 396,961 | 437,567 | 376,759 |
| Oklahoma (Indian Territory) | 110,088 | 98,847 | 123,389 | 95,296 | 38,615 |
| Pennsylvania | 23,724,207 | 22,432,064 | 31,030,345 | 34,503,513 | 39,733,177 |
| Tennessee | 1,001,356 | 718,181 | 862,320 | 929,405 | 825,221 |
| Utah | (b) | (b) | (b) | (b) | (b) |
| Virginia | 1,860,225 | 1,636,905 | 2,184,369 | 2,296,227 | 2,264,720 |
| Washington | 73,119 | 76,993 | 85,715 | 76,896 | 85,860 |
| West Virginia | 4,347,160 | 3,543,338 | 5,329,695 | 5,822,619 | 6,536,795 |
| Maryland | 1,306,707 | 2,015,281 | 2,222,723 | 2,861,934 | 3,415,723 |
| Massachusetts | | | | | |
| Michigan | | | | | |
| Minnesota | | | | | |
| New Jersey | | | | | |
| New York | | | | | |
| Wisconsin | | | | | |
| Wyoming [c] | | | | | |
| Total | 39,423,525 | 36,531,608 | 49,530,677 | 55,746,374 | 61,946,109 |

[a] Includes coal coked in Utah.
[b] Included with Colorado.
[c] Not included in 1907 figures.

*Quantity of coal used in the manufacture of coke in the United States each fifth year, 1880–1907.*

| | Short tons. | | Short tons. |
|---|---|---|---|
| 1880 | 5,237,741 | 1900 | 32,113,543 |
| 1885 | 8,071,126 | 1905 | 49,530,677 |
| 1890 | 18,005,209 | 1907 | 61,946,109 |
| 1895 | 20,848,323 | | |

## QUANTITY AND VALUE OF COAL USED IN COKE MAKING.

The total quantity and value of the coal consumed in the manufacture of coke in 1906 and 1907, with the quantity and value of coal consumed per ton of coke produced, by States and Territories, are shown in the following tables. The quantity of coal consumed in 1907 was 61,946,109 short tons against 55,746,374 short tons in 1906. The value of the coal used in 1907 was $72,784,851, compared with $62,232,524 in 1906, there being a considerable difference in the value as compared with the quantity. In 1906 the average value per ton of the coal used was $1.12, and in 1907 it was $1.18, a difference of 6 cents. There was also a marked difference in the value of the coke product, which was $91,608,034, or $2.52 in 1906, and $111,539,126, or $2.74 per ton, in 1907.

*Quantity and value of coal used in the manufacture of coke in the United States in 1906 and 1907, and quantity and value of same per ton of coke, by States and Territories.*

1906.

| State or Territory. | Coal used (short tons). | Total value of coal. | Value of coal per ton. | Quantity of coal per ton of coke (short tons). | Value of coal to a ton of coke. |
|---|---|---|---|---|---|
| Alabama | 5,184,597 | $6,582,102 | $1.27 | 1.708 | $2.169 |
| Colorado[a] | 2,566,196 | 2,544,677 | .992 | 1.762 | 1.748 |
| Georgia | 128,052 | 151,659 | 1.18 | 1.822 | 2.15 |
| Illinois | 362,163 | 968,351 | 2.67 | 1.347 | 3.596 |
| Indian Territory | 95,296 | 124,383 | 1.305 | 1.914 | 1.498 |
| Kansas | 2,807 | 3,306 | 1.177 | 1.653 | 1.946 |
| Kentucky | 148,448 | 65,648 | .44 | 2.004 | .882 |
| Montana | 69,045 | 210,615 | 3.05 | 1.808 | 5.514 |
| New Mexico | 261,609 | 246,460 | .942 | 1.77 | 1.667 |
| Ohio | 437,567 | 823,749 | 1.88 | 1.488 | 2.797 |
| Pennsylvania | 34,503,513 | 35,395,374 | 1.025 | 1.496 | 1.533 |
| Tennessee | 929,405 | 955,739 | 1.028 | 1.922 | 1.976 |
| Virginia | 2,296,227 | 2,251,143 | .98 | 1.455 | 1.426 |
| Washington | 76,896 | 154,964 | 2.015 | 1.684 | 3.393 |
| West Virginia | 5,822,619 | 5,230,561 | .898 | 1.567 | 1.407 |
| Maryland | 2,861,934 | 6,523,793 | 2.28 | 1.372 | 3.128 |
| Massachusetts | | | | | |
| Michigan | | | | | |
| Minnesota | | | | | |
| New Jersey | | | | | |
| New York | | | | | |
| Wisconsin | | | | | |
| Wyoming | | | | | |
| Total | 55,746,374 | 62,232,524 | 1.116 | 1.531 | 1.709 |

1907.

| | | | | | |
|---|---|---|---|---|---|
| Alabama | 4,973,296 | $6,656,742 | $1.34 | 1.646 | $2.205 |
| Colorado[a] | 2,388,911 | 2,563,433 | 1.07 | 1.680 | 1.798 |
| Georgia | 136,031 | 167,704 | 1.23 | 1.815 | 2.232 |
| Illinois | 514,983 | 1,343,410 | 2.61 | 1.382 | 3.607 |
| Kansas | 11,392 | 14,777 | 1.30 | 1.816 | 2.361 |
| Kentucky | 129,538 | 66,170 | .51 | 1.933 | .986 |
| Montana | 68,948 | 242,327 | 3.51 | 1.693 | 5.942 |
| New Mexico | 446,140 | 618,043 | 1.39 | 1.683 | 2.339 |
| Ohio | 376,759 | 654,588 | 1.74 | 1.392 | 2.422 |
| Oklahoma (Indian Territory) | 38,615 | 56,697 | 1.47 | 2.023 | 2.974 |
| Pennsylvania | 39,733,177 | 42,732,546 | 1.08 | 1.499 | 1.619 |
| Tennessee | 825,221 | 1,108,820 | 1.34 | 1.765 | 2.365 |
| Virginia | 2,264,720 | 2,443,067 | 1.08 | 1.466 | 1.583 |
| Washington | 85,860 | 232,821 | 2.71 | 1.650 | 4.472 |
| West Virginia | 6,536,795 | 5,957,568 | .92 | 1.589 | 1,462 |
| Maryland | 3,415,723 | 7,926,138 | 2.32 | 1.351 | 3.134 |
| Massachusetts | | | | | |
| Michigan | | | | | |
| Minnesota | | | | | |
| New Jersey | | | | | |
| New York | | | | | |
| Wisconsin | | | | | |
| Total | 61,946,109 | 72,784,851 | 1.18 | 1.519 | 1.792 |

[a] Includes Utah

The following table shows approximately the quantity of coal required to produce a ton of coke in 1880, 1890, 1900, and each year since 1901. It will be observed that during the last three years there has been a steady decrease in the consumption of coal per unit of coke, due for the most part to the development of by-product manufacture, in which the yield of coke is considerably more than in beehive ovens.

*Coal required to produce a ton of coke, in tons and pounds.*

| Year. | Tons. | Pounds. | Year. | Tons. | Pounds. |
|---|---|---|---|---|---|
| 1880 | 1.57 | 3,140 | 1903 | 1.56 | 3,120 |
| 1890 | 1.56 | 3,120 | 1904 | 1.544 | 3,088 |
| 1900 | 1.57 | 3,140 | 1905 | 1.537 | 3,074 |
| 1901 | 1.57 | 3,140 | 1906 | 1.531 | 3,062 |
| 1902 | 1.56 | 3,120 | 1907 | 1.519 | 3,038 |

## YIELD OF COAL IN COKE.

By yield of coal in coke is meant the percentage by weight of the constituents of the coal that remain as coke after the process of coking has been completed. During the last few years the average yield of coal in coke was reported about 64 per cent. This is believed to have been somewhat excessive. For reasons previously stated in connection with the quantity of coal made into coke it is not always possible to obtain exact information on this point, as in many instances the coal is not weighed before being charged into the ovens, and the quantity consumed is largely an estimate, based sometimes upon the measured bushel or car and sometimes upon the cubical contents of the "larry," and sometimes upon the amount paid to the miner for mining the coal. What has been said in regard to the decreased consumption of coal per ton of coke in connection with the preceding tables, due to a larger production in by-product ovens, is also applicable here in regard to the increased percentage yield in the last four years. In 1903 the average percentage yield of coal in coke for the United States was 64.1. In 1904 it had increased to 64.8 per cent; in 1905 to 65.1 per cent; in 1906 to 65.3 per cent, and in 1907 to 65.8 per cent. During this period the percentage to the total coke product of the by-product coke made was in 1903 7.4; in 1904, 11; in 1905, 10.7; in 1906, 12.5; and in 1907, 13.75 per cent. The following table shows the percentage yield of coal in coke in each State and Territory during the last five years, and for the United States each ten years since 1880 and each year since 1901:

*Percentage yield of coal in coke, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | 60 | 58.6 | 58.4 | 58.5 | 61.0 |
| Colorado [a] | 59.3 | 57.3 | 58.2 | 56.7 | 59.5 |
| Georgia | 58.5 | 57.3 | 59.3 | 54.9 | 55.1 |
| Illinois |  | 54.6 | 61.3 | 74.2 | 72.3 |
| Kansas | 46.5 | 65 | 68 | 60.5 | 55.0 |
| Kentucky | 46.5 | 45.7 | 51.4 | 49.9 | 51.7 |
| Missouri | 61.2 | 64 | 61.9 |  |  |
| Montana | 54.9 | 53 | 45.8 | 55.3 | 59.0 |

[a] Average, including Utah

*Percentage yield of coal in coke, 1903–1907, by States and Territories*—Continued.

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| New Mexico | 59.4 | 61.7 | 60.4 | 56.5 | 59.4 |
| Ohio | 68 | 66 | 69.8 | 67.2 | 71.8 |
| Oklahoma (Indian Territory) | 45 | 45.3 | 44.4 | 52.2 | 49.4 |
| Pennsylvania | 65.9 | 66.2 | 66.3 | 66.8 | 66.7 |
| Tennessee | 54.6 | 52.8 | 54.3 | 52.0 | 56.6 |
| Virginia | 63.2 | 67.3 | 68.6 | 68.7 | 68.2 |
| Washington | 62.4 | 59 | 62 | 59.4 | 60.6 |
| West Virginia | 62.3 | 64.4 | 63.8 | 63.8 | 62.9 |
| Maryland<br>Massachusetts<br>Michigan<br>New Jersey<br>New York<br>Wisconsin<br>Wyoming [a] | 71.3 | 72 | 74.7 | 72.9 | 74.0 |
| Total average | 64.1 | 64.8 | 65.1 | 65.3 | 65.8 |

[a] Not included in 1907 figures.

*Percentage yield of coal in coke, 1880–1906.*

| | | | | | |
|---|---|---|---|---|---|
| 1880 | 63 | 1902 | 64.1 | 1905 | 65.1 |
| 1890 | 64 | 1903 | 64.1 | 1906 | 65.3 |
| 1900 | 63.9 | 1904 | 64.8 | 1907 | 65.8 |
| 1901 | 63.7 | | | | |

## CONDITION IN WHICH COAL IS CHARGED INTO THE OVENS.

In the following tables will be found a statement of the condition in which the coal is charged into the ovens in the several States and Territories for the last two years, with a résumé of the corresponding statistics for each five years prior to 1905. It has been found, through several years of experience, that in many of the coke-making districts the quality of the coke has been materially improved through the washing of the coal before being charged into the ovens. This is particularly true in regard to slack coal used for making coke. Practically all of the coal which is reported as mine-run and which is washed before being charged into the ovens is crushed before washing, in order to effect a more satisfactory separation of the slate, pyrite, and other impurities which exist in the coal. From two-thirds to three-fourths of the entire quantity of coal used in coke making is run-of-mine coal, most of which (88 per cent in 1907) is charged into the ovens without being washed. Another lesson which has been learned through experience in coke making in the United States is that the coking process is in many cases facilitated and a better strength and structure of the coke obtained when the coal is disintegrated before being charged into the ovens, and a large quantity of the run-of-mine coal is crushed or disintegrated before coking whether it is washed or not. This coal is not reported as slack. All of the coal charged into by-product ovens is crushed before coking. Partially on account of the extraordinary demand for coke which prevailed during the first nine and one-half months of 1907, the quantity of run-of-mine coal which is washed before being charged into the oven shows a decided decrease as compared with 1906. While the demand was at its height the necessity for the careful preparation of the coal before coking was not so pronounced as in years where consumers were more exacting in their requirements. It is for this reason that the quantity of unwashed run-of-mine coal charged into the ovens in 1907 shows an increase from 34,748,258 short tons in 1906 to 41,065,584 tons in 1907, while the quantity of washed run-of-mine coal shows a decrease from 7,377,403 short tons in 1906 to 5,589,735 short tons in 1907. It also appears that while there was an increase of 1,415,540 tons, or from 7,784,801 short tons to 9,200,341 tons in the quantity of unwashed slack used, the quantity of washed slack increased only 254,537 tons, or from 5,835,912 tons in 1906 to 6,090,449 tons in 1907. The total quantity of washed coal (run-of-mine and slack) used in 1907 was 11,680,184 tons, or 19 per cent of the total quantity of coal used, as against 13,620,713 short tons, or 24.4 per cent of slack coal used in 1906. This indicates a decrease of 5.4 per cent in the quantity of slack coal used in 1907 as compared with the preceding year. The unwashed coal used in 1907 amounted to 50,265,925 short tons, of which 41,065,584 short tons were run-of-mine and 9,200,341 tons slack. The total quantity of run-of-mine coal washed and unwashed used increased from 42,125,661 tons in 1906 to 46,655,319 tons in 1907, while the slack coal used increased from 13,620,713 short tons to 15,290,790 tons in 1907.

Among the more important coke-producing States it is observed that in Pennsylvania less than 10 per cent of the coal used in 1907 was slack, and that 6.3 per cent of the run-of-mine coal used in 1907 was washed, as against 12.6 per cent in 1906. In West Virginia nearly two-thirds of the coal charged into the ovens is slack, and of this less than 5 per cent in 1907 was washed. In 1906 nearly 10 per cent of the slack coal made into coke in West Virginia was washed. Only a little more than 1 per cent of the run-of-mine coal made into coke in West Virginia is washed. In Alabama from 40 to 60 per cent of the coal used is slack, practically all of which is washed before charging into the ovens. Of the run-of-mine coal used in Alabama in 1906 nearly two-thirds was washed. In Virginia all of the coal made into coke in 1907 was reported as unwashed, though in 1906 10 per cent of the coal was washed. In Colorado and Utah about 70 per cent of the coal made into coke in 1906 and 1907 was slack, and while in 1906 three-fourths of this was washed, in 1907 44 per cent was unwashed. All of the coal used in coke making in New Mexico is slack, nearly all of which is washed. In Tennessee the coal used may be evenly divided between run-of-mine and slack. All of the slack and most of the run-of-mine is washed.

*Character of coal used in the manufacture of coke, by States and Territories, in 1906 and 1907, in short tons.*

1906.

| State or Territory. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| Alabama | 1,493,549 | 1,810,089 | 121,122 | 1,759,837 | 5,184,597 |
| Colorado[a] | 4,866 | 703,440 | 1,065,353 | 792,537 | 2,566,196 |
| Georgia | 0 | 26,488 | 0 | 101,564 | 128,052 |
| Illinois | 251,870 | 0 | 0 | 110,293 | 362,163 |
| Indian Territory | 50,802 | 0 | 0 | 44,494 | 95,296 |
| Kansas | 0 | 0 | 2,807 | 0 | 2,807 |
| Kentucky | 1,000 | 0 | 65,126 | 82,322 | 148,448 |
| Montana | 12,935 | 56,110 | 0 | 0 | 69,045 |
| New Mexico | 0 | 0 | 0 | 261,609 | 261,609 |
| Ohio | 356,540 | 0 | 38,737 | 42,290 | 437,567 |
| Pennsylvania | 27,471,566 | 3,972,712 | 1,584,152 | 1,475,083 | 34,503,513 |

[a] Includes Utah.

*Character of coal used in the manufacture of coke, by States and Territories, in 1906 and 1907, in short tons*—Continued.

1906—Continued.

| State or Territory. | Run of mine. |  | Slack. |  | Total. |
|---|---|---|---|---|---|
|  | Unwashed. | Washed. | Unwashed. | Washed. |  |
| Tennessee | 81,825 | 509,532 | 142,843 | 195,205 | 929,405 |
| Virginia | 1,014,299 | 228,347 | 1,053,581 | 0 | 2,296,227 |
| Washington | 0 | 70,685 | 0 | 6,211 | 76,896 |
| West Virginia | 2,093,483 | 0 | 3,388,877 | 340,259 | 5,822,619 |
| Maryland<br>Massachusetts<br>Michigan<br>Minnesota<br>New Jersey<br>New York<br>Wisconsin<br>Wyoming | 1,915,523 | 0 | 322,203 | 624,208 | 2,861,934 |
| Total | 34,748,258 | 7,377,403 | 7,784,801 | 5,835,912 | 55,746,374 |

1907.

| State or Territory. | Run of mine. |  | Slack. |  | Total. |
|---|---|---|---|---|---|
|  | Unwashed. | Washed. | Unwashed. | Washed. |  |
| Alabama | 1,020,907 | 1,697,913 | 27,433 | 2,227,043 | 4,973,296 |
| Colorado [a] | 2,956 | 676,226 | 1,055,189 | 654,540 | 2,388,911 |
| Georgia | 0 | 41,000 | 0 | 95,031 | 136,031 |
| Illinois | 311,999 | 0 | 194,389 | 8,595 | 514,983 |
| Kansas | 0 | 0 | 11,392 | 0 | 11,392 |
| Kentucky | 30,632 | 0 | 0 | 98,906 | 129,538 |
| Montana | 18,648 | 50,300 | 0 | 0 | 68,948 |
| New Mexico | 0 | 0 | 2,498 | 443,642 | 446,140 |
| Ohio | 268,637 | 45,712 | 36,514 | 25,896 | 376,759 |
| Oklahoma (Indian Territory) | 0 | 0 | 38,615 | 0 | 38,615 |
| Pennsylvania | 33,589,751 | 2,267,142 | 2,566,090 | 1,310,194 | 39,733,177 |
| Tennessee | 54,397 | 386,094 | 0 | 384,730 | 825,221 |
| Virginia | 1,271,518 | 0 | 993,202 | 0 | 2,264,720 |
| Washington | 0 | 72,268 | 0 | 13,592 | 85,860 |
| West Virginia | 2,451,811 | 27,067 | 3,874,817 | 183,100 | 6,536,795 |
| Maryland<br>Massachusetts<br>Michigan<br>Minnesota<br>New Jersey<br>New York<br>Wisconsin | 2,044,328 | 326,013 | 400,202 | 645,180 | 3,415,723 |
| Total | 41,065,584 | 5,589,735 | 9,200,341 | 6,090,449 | 61,946,109 |

[a] Includes Utah

In the following table are given the statistics regarding the character of the coal used in coke making for the years 1890, 1895, 1900, 1905, and 1907:

*Character of coal used in the manufacture of coke in the United States, 1890–1907, in short tons.*

| Year. | Run of mine. |  | Slack. |  | Total. |
|---|---|---|---|---|---|
|  | Unwashed. | Washed. | Unwashed. | Washed. |  |
| 1890 | 14,060.907 | 338,563 | 2,674,492 | 931,247 | 18,005,209 |
| 1895 | 15,609,875 | 237,468 | 3,052,246 | 1,948,734 | 20,848,323 |
| 1900 | 21,062,090 | 1,369,698 | 5,677,006 | 4,004,749 | 32,113,543 |
| 1905 | 31,783,314 | 3,187,994 | 8,196,226 | 6,363,143 | 49,530,677 |
| 1907 | 41,065,584 | 5,589,735 | 9,200,341 | 6,090,449 | 61,946,109 |

## COKE MAKING IN BY-PRODUCT OVENS.

According to reports received from the manufacturers of coke in by-product ovens, the total number of this type of oven completed to the close of 1907 was 3,892, against 3,603 in 1906, and 3,159 in 1905. The increase in 1907 over 1906 was 289 ovens. The production of by-product coke in 1907 amounted to 5,607,899 short tons, as against 4,558,127 short tons in 1906 and 3,462,348 tons in 1905. The increase in 1907 over 1906 amounted to 1,049,772 short tons, or 23 per cent. The increase in 1906 over 1905 was 1,095,779 short tons, or 31.6 per cent. Of the 3,892 ovens in 1907, 81 were idle, the idle ovens being 25 Semet-Solvay ovens at Sharon, Pa., and 56 Newton-Chambers ovens at Pocahontas, Va., which have not been in practical operation since they were first installed. In 1906, out of the 3,603 by-product ovens, 241 were idle.

The production of by-product coke in 1907 was from 3,811 active ovens, the average output from each of which was 1,472 short tons of coke, as compared with the average production for each oven in 1906 of 1,356 short tons, and in 1905 of 1,158.8 tons. The average production from beehive ovens in blast in 1907 was 386.8 short tons, as compared with 373.6 tons in 1906, and 365.8 tons in 1905. The quantity of coal consumed in the manufacture of the 5,607,899 tons of by-product coke in 1907 was 7,506,174 short tons, indicating a yield of coal in coke of 75 per cent. In 1906 the average percentage yield of coal in coke in by-product ovens was 73.6 per cent, and in 1905 it was 74.8 per cent. This is a much larger yield than it is possible to obtain in beehive ovens, as a portion of the fixed carbon in the coal is unavoidably burned in beehive-oven practice, while in the retort oven the operation is one of distillation only without the admission of air, and all of the fixed carbon remains as coke. As previously shown, the average yield of coal in coke, including the output of by-product recovery ovens in the United States for the last few years has been about 65 per cent, and this is probably higher than the actual results obtained. The increase in the production of by-product coke is responsible for the average yield of coal in coke increasing in each of the last five years from 64.1 per cent in 1903 to 64.8 per cent in 1904, to 65.1 per cent in 1905, to 65.3 in 1906, and to 65.8 in 1907.

At the risk of being charged with repeating what has already been said, the writer again calls attention to the tenacity with which coke manufacturers of the United States cling to the beehive-oven practice of coke making and to the comparatively slow increase which has characterized the retort-oven method of manufacture as developed in the United States, particularly in the last three of four years. From 1900 to 1903 there was a gratifying condition shown by the number of ovens in course of construction at the end of each year, there having been between 1,000 and 1,500 ovens building during these years, many of which were completed during the period. The number of by-product ovens completed increased from 1,956 in 1903 to 2,910 in 1904, with 832 under construction at the end of that year. Part of these ovens under construction at the end of 1904 were completed in 1905, and some in 1906, the total number of completed ovens at the close of the latter year being 3,603. The amount of new work under way during the last four years, however, has shown a marked decrease as compared with the preceding four years. At the end of 1905 there were only 417 ovens under construction, and at the end of 1906 the number of ovens under construction was reduced to 112. Some additional new work was begun in 1907, and the number of ovens under construction at the close of that year was 330, of which 280 were the experimental plant of Koppers regenerative by-product ovens building by the Illinois Steel Company, at Joliet, Ill., it being reported that it was the intention of the United States Steel Corporation to construct 1,000 of this type of oven at Gary, Ind., if this experimental plant proved satisfactory. The other 50 ovens building at the close of 1907 are an addition to the United Otto plant at Hamilton, Ohio, doubling the number of ovens at that place.

When the economies which may be effected by the use of the retort ovens have been so clearly demonstrated, not only by the plants which have been constructed in the United States, but more emphatically through the much more extensive development of by-product coke manufacture in Europe, the condition in the United States, as shown by the statistics for the last four years, is somewhat difficult to understand. The economy shown by the higher yield of coal in coke has already been referred to, and, as previously stated, the production of coke in the by-product ovens of the United States in 1907 amounted to 5,607,899 short tons, valued at $21,665,157. The total value of by-products obtained in the manufacture of this coke was $7,548,071, this value and the quantity being distributed as follows:

*Value of by-products obtained in manufacture of coke in retort ovens in 1907.*

| | Quantity. | Value. |
|---|---|---|
| Gas.........................................................M cubic feet.. | 20,516,731 | $3,130,839 |
| Tar..............................................................gallons.. | 53,995,795 | 1,242,530 |
| Ammonia, sulphate or reduced to equivalent in sulphate.......pounds.. | 125,372,360 | 3,174,702 |
| Total............................................................... | .............. | 7,548,071 |

The gas included in the foregoing statement is the "surplus" not consumed in the coking process, and which is either sold or used at manufacturing establishments operated in connection with the coke-oven plant. In a few instances where the surplus gas is consumed by the producing companies the quantity is not measured, nor was any value placed upon it in the reports made to the Survey. In such cases careful estimates have been made, based upon the average surplus gas obtained from similar coals used at ovens of the same type. The value, similarly estimated, has been placed at from 10 to 15 cents per thousand cubic feet.

The coal consumed in retort ovens in 1907 amounted to 7,506,174 short tons. The quantity of coal used in beehive ovens was 54,439,935 short tons, from all of which the possible by-products are apparently wasted. Assuming that the coal consumed in beehive ovens was of the same average quality as that charged into the retort ovens and that the prices would be not less than 80 per cent of those ruling in 1907, the value of recoverable products which were thus apparently wasted last year amounted to $44,000,000, a sum equal to nearly 80 per cent of the total value of all the coal used in beehive ovens during the year. At the prices which prevailed in 1907 the value of the by-products wasted in beehive coke ovens was a little over $55,000,000.

The value of the by-products from the retort ovens in 1907 was a little more than one-third the value of the coke produced in them.

It should be remembered, however, that beehive ovens are located in the coal mining regions and that the cost of the coal charged into them represents only a little more than that represented by the expense of mining the coal, whereas in locating by-product recovery plants provision must be made for utilizing or marketing the by-products. It is for this reason that in the much larger number of cases the recovery plants are established near the larger cities and at considerable distances from the mining regions, and the expense of transportation is added to the mining cost of the coal. Hence it is that the value of the 7,506,174 tons of coal charged into by-product ovens in 1907 was $15,920,017, or over $2 per ton, while the 54,439,935 tons of coal used in beehive ovens was $56,864,834, or $1.05 per ton. It must also be remembered that the original cost of installation for a by-product recovery plant is from 4 to 5 times that of a beehive plant of equal capacity. These disadvantages are in turn partly offset by the higher percentage yield of coke in the retort ovens and a lower delivery charge on the coke produced. In the case of beehive coke, railroad transportation expense is borne by the coke, while in retort oven practice all, or nearly all, of the freight charge is borne by the coal.

The total value of the 5,607,899 tons of by-product coke produced in 1907 was $21,665,157, an average of $3.86 per ton. The value of the 35,171,665 tons of beehive coke made in 1907 was $89,873,969, or $2.56 per ton. If we consider that the difference in the value of the by-product coke and beehive coke was due only to the difference in freight charges, then the total value of the entire product of beehive coke made in 1907 would, if made in retort ovens close to the market, have been worth $135,750,000. Add to this the value of the by-products that should have been recovered of $44,000,000, at 80 per cent of the market price in 1907, the total value of the coke and by-products would have amounted to nearly $180,000,000 instead of the value of $89,873,969 for the beehive coke alone. The value of the coal charged into these ovens would have been $108,879,870 instead of $56,864,834. Carrying the hypothesis further, the difference between the value of the coke and by-products if the coal had been coked in retort ovens and the value of the coke alone from the beehive ovens was, say, $90,000,000. From this should be deducted the difference between what the value of the coal would have been at retort ovens, and what it was at beehive ovens, i. e., $52,000,000. The remainder ($38,000,000) less the difference in operating expenses, wear and tear, interest on capital, etc., may be considered as approximately the actual net loss in value as the result of beehive coke production compared with by-product coke practice in 1907.

One of the reasons that has been given for the apparent lack of progress in retort oven building in the last four years is the lack of profitable markets for the by-products of coal tar, and this has contributed to the backwardness of the United States in the development of the chemical industries depending upon coal tar as a raw material, and yet this country is importing coal tar products to the value of several million dollars annually. It is also well known that the development of the coal-briquetting industry has been retarded

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because of the lack of assurance of a satisfactory supply of suitable coal tar pitch for binding material, and there is also an increasing demand for creosoting oils for the preservation of timber.

There does not appear to be any trouble in disposing of the ammonia, for which a good demand exists, and the practicability of long distance transmission of the gas has been successfully demonstrated, thus insuring markets for the surplus of this retort-oven product. The United Otto oven plant at Camden, N. J., is distributing gas to Plainfield, New Brunswick, and other cities and towns, the maximum distance being 83 miles.

At the present time, when the conservation of the natural resources of the United States is being so earnestly discussed, this matter of waste in coke manufacture is one which might well be given serious consideration.

The first plant of by-product ovens built in the United States was one of 12 Semet-Solvay ovens at Syracuse, N. Y. It was completed in 1893, and the production in that year amounted to 12,850 tons. This plant has since been increased to 40 ovens. The first plant of United Otto ovens was constructed at Johnstown, Pa., and consisted of 60 ovens operated in connection with the (now) Cambria Steel Company. The main difference in these two types of oven lies in the arrangement of the flues for the combustion of the gases used in heating them. In one the flues are vertical and in the other they are horizontal. Most of the by-product ovens constructed in this country have been one of these two designs. At the close of 1907 there were 1,270 Semet-Solvay ovens in operation, with 25 idle; of the United Otto type there were 2,002 completed and 50 building. In addition to these there were 387 Rothberg ovens in operation during the year, but no new ones of this type were under construction. There were also 152 Newton-Chambers ovens in operation at Vintondale, Pa., during 1907, but no by-products, except of an experimental character, were obtained. The plant of 56 Newton-Chambers ovens constructed at Pocahontas, Va., has not been in operation for several years.

In the following table is shown the record of by-product coke making since 1893, when the first plant was established at Syracuse, N. Y.:

*Record of by-product coke making, 1893–1907.*

| Year. | Ovens. | | Production (short tons). | Year. | Ovens. | | Production (short tons). |
|---|---|---|---|---|---|---|---|
| | Built. | Building. | | | Built. | Building. | |
| 1893 | 12 | 0 | 12,850 | 1901 | 1,165 | 1,533 | 1,179,900 |
| 1894 | 12 | 60 | 16,500 | 1902 | 1,663 | 1,346 | 1,403,588 |
| 1895 | 72 | 60 | 18,521 | 1903 | 1,956 | 1,335 | 1,882,394 |
| 1896 | 160 | 120 | 83,038 | 1904 | 2,910 | 832 | 2,608,229 |
| 1897 | 280 | 240 | 261,912 | 1905 | 3,159 | 417 | 3,462,348 |
| 1898 | 520 | 500 | 294,445 | 1906 | 3,603 | 112 | 4,558,127 |
| 1899 | 1,020 | 65 | 906,534 | 1907 | [a] 3,892 | [b] 330 | 5,607,899 |
| 1900 | 1,085 | 1,096 | 1,075,727 | | | | |

[a] Includes 1,295 Semet-Solvay, 2,002 United Otto, 387 Rothberg, and 208 Newton-Chambers ovens.
[b] Includes 50 United Otto, and 280 Koppers ovens.

In the following table is shown the record of by-product coke ovens, by States, at the close of 1903–1907:

*Record of by-product ovens, by States, 1903–1907.*

| State. | Dec. 31, 1903. | | Dec. 31, 1904. | | Dec. 31, 1905. | | Dec. 31, 1906. | | Dec. 31, 1907. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. |
| Alabama | 240 | 40 | 240 | 40 | 280 | 0 | 280 | 0 | 280 | 0 |
| Illinois | 0 | 120 | 0 | 120 | 120 | 0 | 160 | 0 | 160 | 280 |
| Maryland | 200 | 0 | 200 | 0 | 200 | 0 | 200 | 0 | 200 | 0 |
| Massachusetts | 400 | 0 | 400 | 0 | 400 | 0 | 400 | 0 | 400 | 0 |
| Michigan | 75 | 60 | 135 | 0 | 135 | 15 | 150 | 0 | 150 | 0 |
| Minnesota | 0 | 50 | 50 | 0 | 50 | 0 | 50 | 0 | 50 | 0 |
| New Jersey | 100 | 0 | 100 | 0 | 100 | 50 | 150 | 0 | 150 | 0 |
| New York | 40 | 500 | 252 | 658 | 399 | 0 | 540 | 0 | 540 | 0 |
| Ohio | 50 | 66 | 116 | 14 | 130 | 0 | 130 | 0 | 155 | 50 |
| Pennsylvania | 675 | 419 | 1,061 | 0 | 1,089 | 272 | 1,207 | 112 | 1,471 | 0 |
| Virginia | 56 | 0 | 56 | 0 | 56 | 0 | 56 | 0 | 56 | 0 |
| West Virginia | 120 | 0 | 120 | 0 | 120 | 0 | 120 | 0 | 120 | 0 |
| Wisconsin | 0 | 80 | 80 | 0 | 80 | 80 | 160 | 0 | 160 | 0 |
| Total | 1,956 | 1,335 | 2,910 | 832 | 3,159 | 417 | 3,603 | 112 | 3,892 | 330 |

The distribution by States and by kinds of by-product ovens built and building in the United States at the close of 1907 is shown in the following table:

*Kinds of by-product coke ovens built and building in the United States, by States, at the close of 1907.*

| State. | Semet-Solvay. | | United Otto.[a] | | Rothberg. | | Newton-Chambers. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. |
| Alabama | 280 | | | | | | | | 280 | 0 |
| Illinois | 160 | | | | | | | | 160 | [b] 280 |
| Maryland | | | 200 | | | | | | 200 | 0 |
| Massachusetts | | | 400 | | | | | | 400 | 0 |
| Michigan | 120 | | 30 | | | | | | 150 | 0 |
| Minnesota | | | 50 | | | | | | 50 | 0 |
| New Jersey | | | 150 | | | | | | 150 | 0 |
| New York | 70 | | 188 | | 282 | | | | 540 | 0 |
| Ohio | | | 50 | 50 | 105 | | | | 155 | 50 |
| Pennsylvania | 385 | | 934 | | | | 152 | | 1,471 | 0 |
| Virginia | | | | | | | 56 | | 56 | 0 |
| West Virginia | 120 | | | | | | | | 120 | 0 |
| Wisconsin | 160 | | | | | | | | 160 | 0 |
| Total | 1,295 | | 2,002 | 50 | 387 | | 208 | | 3,892 | 330 |

[a] Includes the Otto-Hoffmann and Schniewind types.
[b] Koppers' regenerative ovens.

The following table, originally compiled by Mr. Albert Ladd Colby, has been revised by Mr. C. G. Atwater, of the United Coke and Gas Company, Whitehall Building, New York City, and by Mr. W. H. Blauvelt, of the Semet-Solvay Company, Syracuse, N. Y.

This table shows, in addition to the number of ovens at each by-product oven plant in the United States and Canada, the uses to which the coke and gas are put, the dates the plants were put in operation, and other interesting information regarding their construction and operation. The statement includes also the garbage-carbonizing plant of Semet-Solvay ovens at Boston, Mass. This plant was originally planned for 400 ovens, but only 7 were completed. The plant has since been partially wrecked by fire and has been dismantled.

*Complete list of by-product coke-oven plants of the United States and Canada, January 1, 1908.*

| State. | Town. | System. | Name of company. | Number of installments. | Date put in operation. | Number of ovens. | Uses of coke. | Uses of surplus gas. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| Mass. | Boston | Semet-Solvay | The New England Sanitary Product Co. (plant for carbonizing garbage tankage). | | 1898 | 7 | Fertilizer base | Fuel | Damaged by fire and dismantled. |
| | Everett | Otto-Hoffmann | New England Gas and Coke Co. | | June, 1899 | 400 | Domestic and locomotive in about equal proportion. | Illuminating gas and fuel gas; 6,500,000 to 7,500,000 cubic feet daily of illuminating gas. | First illuminating-gas system installed. |
| N. Y. | Syracuse | Semet-Solvay | Solvay Process Co. | First | Jan., 1893 | 12 | Burning limestone; also iron foundry. | Fuel | First by-product plant in United States. Main purpose to obtain ammonia for alkali works. |
| | | | | Second | 1896 | [a]25 | | | |
| | | | | Third | Bet. 1900-1903. | [a]40 | | | |
| | Geneva | do | The Empire Coke Co. | First | Aug., 1904 | 30 | Foundry and domestic. | Illuminating | |
| | Buffalo | United Otto | Lackawanna Steel Co. | do | May, 1904 | [b]564 | Blast furnace | Fuel gas | Used stamped coal, but went back to top-charging, 1907. |
| | do | Rothberg | do | do | | 282 | do | do | |
| N. J. | Camden | Otto-Hoffmann | South Jersey Gas, Electric, and Traction Co. | do | About Jan., 1903. | 100 | Foundry and domestic (domestic coke crushed and sized for sale). | Illuminating gas and fuel gas 2,500,000 to 3,000,000 cubic feet. Illuminating gas pumped daily under 10 pounds pressure to Trenton, 38 miles distant. In 1906 extended delivery of illuminating gas to New Brunswick and Plainfield, 83 miles from Camden. Towns now included: Camden, Bordentown, Woodbury, Trenton, New Brunswick, Plainfield, and smaller towns. | First to install enrichment by benzol transfer. |
| | | United Otto | | Second | July, 1906 | 50 | | | |
| Pa. | Dunbar | Semet-Solvay | The Dunbar Furnace Co. | First | Aug., 1896 | 50 | Blast furnace | Fuel gas | |
| | | | | Second | July, 1903 | 60 | | | |
| | Chester | do | The Suburban Gas Co. | First | Apr., 1904 | 40 | Blast furnace | Illuminating | |
| | Sharon | do | The Carnegie Steel Co. | do | Oct., 1896 | 25 | do | Fuel gas | |
| | South Sharon | United Otto | Sharon Coke Co. | do | July, 1903 | 212 | do | do | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Glassport | Otto-Hoffmann | Pittsburg Gas and Coke Co. | | Feb., 1897 | 120 | Blast furnace and domestic. Installed a crushing outfit in 1905. | Illuminating gas and fuel gas to McKeesport. | |
| | Johnstown | do | Cambria Steel Co | First | Nov., 1895 | 60 | Blast furnace | Fuel gas and power gas | 60 ovens old type Otto-Hoffmann. |
| | | | | Second | Mar., 1899 | 100 | do | do | 100 ovens United Otto. |
| | | | | Third | Sept., 1904 | 100 | do | do | Do. |
| | | | | Fourth | Feb., 1907 | 112 | do | do | |
| | Lebanon | Semet-Solvay | Pennsylvania Steel Co | First | July, 1904 | 90 | do | Semet-Solvay Co. delivers surplus gas to Pennsylvania Steel Co., which sells it to American Iron and Steel Mfg. Co. for use in heating furnaces and gas engine. | Erected by Semet-Solvay Co. at expense of Pennsylvania Steel Co. "Five high" type of oven. |
| | do | Otto-Hoffmann | Lackawanna Steel Co | do | Mar., 1903 | 232 | do | Fuel gas | Have gone back to top-charging since resumption. |
| | Steelton | Semet-Solvay | Pennsylvania Steel Co | do | Jan., 1907 | 120 | do | do | "Five high" type of oven. |
| W. Va | Benwood | do | National Tube Co | do | Oct., 1898 | 60 | do | do | |
| | | | | Second | Mar., 1901 | 60 | | | |
| Md | Sparrows Point | United Otto | Maryland Steel Co | First | Mar., 1903 | 200 | Blast furnace | Illuminating gas for city of Baltimore, 11 miles distant; 4,000,000 cubic feet daily. | |
| Ala | Ensley (near Birmingham) | Semet-Solvay | Tennessee Coal, Iron and R. R. Co. | do | Oct., 1898 | 120 | do | Fuel gas | |
| | | | | Second | Mar., 1902 | 120 | do | do | |
| | Tuscaloosa | do | Central Iron and Coal Co. | First | Since 1905 | 40 | do | do | "Five high" type of oven. |
| Ohio | Hamilton | Otto-Hoffmann | Hamilton Otto Coke Co. | do | Apr., 1901 | 50 | Mostly domestic; some foundry. Installed crushing outfit 1905. | Illuminating gas for Hamilton; also power gas. | |
| | do | United Otto | do | Second | Not completed. | 50 | Blast furnace | do | |
| | Cleveland | Rothberg | Cleveland Furnace Co. | First | About Apr., 1905. | 80 | do | Fuel gas | Use stamped coal. |
| | | | Wellman-Seaver-Morgan Co. | Second | | 25 | do | do | |
| Ill | Joliet | Koppers | Illinois Steel Co | First | Not completed. | 280 | do | Fuel and power | |
| | South Chicago on Calumet River. | Semet-Solvay | By-products Coke Corporation. | do | Dec., 1905 | 120 | Blast furnace, foundry, and domestic. | Illuminating | |
| | | | | Second | Dec., 1906 | 40 | | | |
| Wis | Milwaukee | do | Milwaukee Coke and Gas Co. | First | Mar., 1904 | 80 | do | do | |
| | | | | Second | Mar., 1906 | 80 | | | |
| Mich | Delray | do | The Solvay Process Co. | First | Sept., 1901 | 30 | Furnace, foundry, domestic, and lime-burning. | Illuminating | |
| | | | | Second | Nov., 1902 | 30 | | | |
| | | | | Third | Mar., 1906 | 60 | | | |

a Increased to.

b Contracted for; 188 completed.

*Complete list of by-product coke-oven plants of the United States and Canada, January 1, 1908*—Continued.

| State. | Town. | System. | Name of company. | Number of installments. | Date put in operation. | Number of ovens. | Uses of coke. | Uses of surplus gas. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| Mich.... | Wyandotte..... | United Otto.... | Michigan Alkali Co... | First ...<br>Second . | Oct., 1902...<br>Aug., 1906 . | 15<br>15 | Burning limestone. | Fuel gas.................... | Use the by-products in their works. |
| Minn.... | Duluth......... | .....do.......... | Zenith Furnace Co... | First ... | July, 1904... | 50 | Blast furnace..... | Illuminating gas for Duluth. | |
| Nova Scotia. | Halifax......... | Semet-Solvay .. | People's Heat and Light Co. | .......... | Apr., 1898 .. | 10 | Domestic......... | Illuminating gas for Halifax. | Originally built by another system. Not in operation. |
| | Sydney......... | Otto-Hoffmann | Dominion Iron and Steel Co. | .......... | Dec., 1900... | 500 | Blast furnace..... | Fuel gas.................... | |

## IMPORTS AND EXPORTS.

The following table gives the quantity and value of coke imported and entered for consumption in the United States from 1902 to 1907, inclusive. In the reports of the Bureau of Statistics of the Department of Commerce and Labor, from which these figures are obtained, the quantities are expressed in long tons of 2,240 pounds. These have been reduced to short tons in order to make them conform to the standard unit of this report.

*Coke imported and entered for consumption in the United States, 1902–1907, in short tons.*

| | | | | | |
|---|---|---|---|---|---|
| 1902 | 140, 489 | $423, 775 | 1905 | 203, 142 | $796, 545 |
| 1903 | 142, 776 | 437, 625 | 1906 | 147, 819 | 570, 150 |
| 1904 | 180, 855 | 648, 521 | 1907 | 135, 968 | 596, 366 |

The quantity of coke exported from the United States has increased each year since 1900. The exports for the last six years are shown in the following table, the quantities in this case also being reduced to short tons:

*Coke exported from the United States since 1902, in short tons.*

| | | | | | |
|---|---|---|---|---|---|
| 1902 | 439, 590 | $1, 785, 188 | 1905 | 670, 939 | $2, 243, 010 |
| 1903 | 466, 351 | 2, 091, 875 | 1906 | 857, 013 | 2, 753, 551 |
| 1904 | 585, 861 | 2, 311, 401 | 1907 | 979, 652 | 3, 206, 793 |

The following table shows the value of the coal-tar products imported into the United States and the duty paid thereon in each year since 1896, inclusive:

*Coal-tar products imported into the United States, 1896–1907.*

| Year. | Salicylic acid. | | Alizarine and colors or dyes, natural and artificial. | | Aniline salts. | | Coal-tar colors or dyes, not specially provided for. | |
|---|---|---|---|---|---|---|---|---|
| | Value. | Duty. | Value. | Duty. | Value. | Duty. | Value. | Duty. |
| 1896[a] | $138, 013 | Free. | $994, 395 | Free. | $662, 459 | Free. | $2, 918, 333 | $729, 583 |
| 1897[a] | 201, 980 | Free. | 1, 023, 425 | Free. | 812, 884 | Free. | 3, 163, 182 | 790, 796 |
| 1898[a] | 28, 688 | $6, 794 | 886, 349 | Free. | 1, 087, 704 | Free. | 3, 723, 288 | 1, 098, 532 |
| 1899[a] | 57, 192 | 18, 536 | 700, 786 | Free. | 743, 130 | Free. | 3, 900, 099 | 1, 170, 030 |
| 1900[a] | 89, 175 | 24, 069 | 771, 336 | Free. | 537, 812 | Free. | 4, 792, 103 | 1, 437, 631 |
| 1901 | 76, 786 | 22, 227 | 713, 392 | Free. | 589, 535 | Free. | 4, 034, 171 | 1, 210, 251 |
| 1902 | 57, 852 | 21, 913 | 1, 028, 327 | Free. | 631, 467 | Free. | 4, 911, 668 | 1, 473, 500 |
| 1903 | 19, 012 | 7, 827 | 660, 464 | Free. | 789, 553 | Free. | 5, 252, 611 | 1, 575, 783 |
| 1904 | 7, 305 | 3, 276 | 636, 418 | Free. | 686, 184 | Free. | 4, 903, 077 | 1, 470, 923 |
| 1905 | 2, 214 | 923 | 625, 491 | Free. | 789, 052 | Free. | 5, 673, 242 | 1, 701, 973 |
| 1906 | 2, 772 | 991 | 661, 155 | Free. | 806, 901 | Free. | 5, 717, 932 | 1, 715, 380 |
| 1907 | 1, 240 | 489 | 782, 368 | Free. | 667, 758 | Free. | 5, 830, 651 | 1, 749, 196 |

| Year. | Coal tar, all preparations, not colors or dyes. | | Coal-tar products not medicinal, not dyes, known as benzol, toluol, etc. | | Total. | |
|---|---|---|---|---|---|---|
| | Value. | Duty. | Value. | Duty. | Value. | Duty. |
| 1896[a] | | | | | $4, 713, 200 | $729, 583 |
| 1897[a] | | | | | 5, 201, 471 | 790, 796 |
| 1898[a] | $134, 416 | $26, 883 | $228, 037 | Free. | 6, 088, 482 | 1, 132, 209 |
| 1899[a] | 221, 101 | 44, 220 | 393, 602 | Free. | 6, 015, 910 | 1, 232, 786 |
| 1900[a] | 274, 946 | 54, 989 | 397, 780 | Free. | 6, 863, 152 | 1, 516, 689 |
| 1901 | 342, 116 | 68, 423 | 383, 559 | Free. | 6, 139, 559 | 1, 300, 901 |
| 1902 | 496, 928 | 99, 386 | 368, 098 | Free. | 7, 494, 340 | 1, 594, 799 |
| 1903 | 544, 176 | 108, 835 | 425, 069 | Free. | 7, 690, 885 | 1, 692, 445 |
| 1904 | 522, 242 | 104, 448 | 391, 645 | Free. | 7, 146, 871 | 1, 578, 647 |
| 1905 | 768, 556 | 153, 711 | 486, 439 | Free. | 8, 344, 994 | 1, 856, 607 |
| 1906 | 864, 067 | 172, 814 | 483, 416 | Free. | 8, 536, 243 | 1, 889, 185 |
| 1907 | 911, 096 | 182, 219 | 653, 288 | Free. | 8, 846, 401 | 1, 931, 904 |

[a] Fiscal years.

## PRODUCTION OF COKE, BY STATES.

### ALABAMA.

For a quarter of a century, from 1880 to 1905, Alabama and West Virginia were close rivals for second place in the rank of coke-producing States, and during the last five years of that period each State held the place alternately. During the last three years West Virginia has outranked Alabama, and as in 1907 the production of West Virginia exceeded that of her rival by over 1,000,000 tons, or about 33⅓ per cent, it would appear that Alabama can no longer aspire to the honor. The effect of the monetary disturbances in October, 1907, was felt in Alabama more seriously than it was in West Virginia, and while West Virginia's production increased substantially, Alabama's fell off slightly, from 3,034,501 short tons in 1906 to 3,021,794 tons in 1907, a loss of 12,707 short tons. Owing, however, to the abnormally high price which prevailed during the first part of the year, the value of Alabama's coke product increased from $8,477,899 in 1906 to $9,216,194, a gain of $738,295, or 8.7 per cent. The advantage possessed by Alabama's coke manufacturers over those in West Virginia is in the home market for the product, and this is shown by the fact that while West Virginia's coke, which is certainly of as good quality as that of Alabama, sold for an average of $2.36 per ton during 1907, Alabama's sold for an average of $3.05, and whereas West Virginia's production exceeded Alabama's by over 1,000,000 tons, the value of West Virginia's product exceeded that of Alabama's by only $500,000.

There were 43 coke-making establishments in Alabama in 1907, an increase of 1 over 1906. The total number of ovens increased from 9,731 in 1906 to 9,889 in 1907. The 43 establishments included 6 with a total of 715 ovens that were idle during 1907, as compared with the same number of establishments and 1,211 ovens idle in 1906. There were 50 new beehive ovens building at the close of 1907, against 160 at the close of 1906. There were 2 by-product recovery plants, with a total of 280 ovens, all of which were operated during 1907. The production of coke in Alabama in 1880, 1890, 1900, and from 1903 to 1907. is shown in the following table:

*Statistics of the manufacture of coke in Alabama, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 4 | 316 | 100 | 106,283 | 60,781 | $183,063 | $3.01 | 57 |
| 1890 | 20 | 4,805 | 371 | 1,809,964 | 1,072,942 | 2,589,447 | 2.41 | 59 |
| 1900 | 30 | 6,529 | 690 | 3,582,547 | 2,110,837 | 5,629,423 | 2.67 | 58.9 |
| 1903 | 39 | 8,764 | 381 | 4,483,942 | 2,693,497 | 7,622,528 | 2.83 | 60 |
| 1904 | 42 | 9,059 | 440 | 3,996,578 | 2,340,219 | 5,716,413 | 2.44 | 58.6 |
| 1905 | 42 | 9,586 | 150 | 4,409,854 | 2,576,986 | 7,646,957 | 2.97 | 58.4 |
| 1906 | 42 | 9,731 | 160 | 5,184,597 | 3,034,501 | 8,477,899 | 2.79 | 58.5 |
| 1907 | 43 | [a] 9,889 | 50 | 4,973,296 | 3,021,794 | 9,216,194 | 3.05 | 61 |

[a] Includes 280 Semet-Solvay ovens.

A considerable increase is noted in the quantity of coal washed before coking in 1907 as compared with 1906, and this is particularly noticeable in the quantity of slack coal used for coking. In 1906 the quantity of washed slack used was 1,759,837 short tons, while in

1907 the quantity of slack washed was 2,227,043 tons. The total quantity of washed coal, including mine run, was 3,924,956 tons, as compared with 3,569,926 tons in 1906. The unwashed coal in 1907 was 1,020,907 short tons of mine run and 27,433 tons of slack, as compared with 1,493,549 tons of mine run and 121,122 tons of slack in 1906.

*Character of coal used in the manufacture of coke in Alabama, 1890–1907, in short tons.*

| Year. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 1,480,669 | ............ | 206,106 | 123,189 | 1,809,964 |
| 1895 | 1,208,020 | ............ | 32,068 | 1,219,377 | 2,459,465 |
| 1900 | 1,729,882 | 152,077 | 165,418 | 1,535,170 | 3,582,547 |
| 1903 | 1,359,450 | 602,446 | ............ | 2,522,046 | 4,483,942 |
| 1904 | 670,271 | 922,864 | 741 | 2,402,702 | 3,996,578 |
| 1905 | 1,297,376 | 1,247,924 | ............ | 1,864,554 | 4,409,854 |
| 1906 | 1,493,549 | 1,810,089 | 121,122 | 1,759,837 | 5,184,597 |
| 1907 | 1,020,907 | 1,697,913 | 27,433 | 2,227,043 | 4,973,296 |

## COLORADO AND UTAH.

The statistics of the manufacture of coke in Colorado and Utah are combined in order not to divulge individual operations, there being but two establishments in Utah, both of which are owned by one company. The production of the two States in 1907 amounted to 1,421,579 short tons, valued at $4,747,436, against 1,455,905 short tons, valued at $4,504,748 in 1906, indicating a decrease of 34,326 short tons, or 2.36 per cent in quantity, and a gain in value of $242,688, or 5.39 per cent. The average price per ton advanced from $3.09 in 1906 to $3.34 in 1907.

One new establishment was completed in Colorado in 1907, increasing the total for the two States from 17 to 18, and the total number of ovens from 4,103 to 4,683 in 1907. One establishment of 23 ovens was idle both in 1906 and 1907.

The statistics of the manufacture of coke in Colorado and Utah in 1880, 1890, 1900, and for the last five years are shown in the following table:

*Statistics of the manufacture of coke in Colorado and Utah, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 1 | 200 | 50 | 51,891 | 25,568 | $145,226 | $5.68 | 49 |
| 1890 | 8 | 916 | 30 | 407,023 | 245,756 | 959,246 | 3.90 | 60 |
| 1900 | 14 | 1,092 | 0 | 997,861 | 618,755 | 1,746,732 | 2.82 | 62 |
| 1903 | 18 | 3,959 | 0 | 1,776,974 | 1,053,840 | 3,089,783 | 2.93 | 59.3 |
| 1904 | 17 | 3,923 | 0 | 1,376,354 | 789,060 | 2,590,251 | 3.28 | 57.3 |
| 1905 | 17 | 3,925 | 150 | 2,368,365 | 1,378,824 | 4,157,517 | 3.02 | 58.2 |
| 1906 | 17 | 4,103 | 250 | 2,566,196 | 1,455,905 | 4,504,748 | 3.09 | 56.7 |
| 1907 | 18 | 4,683 | 50 | 2,388,911 | 1,421,579 | 4,747,436 | 3.34 | 59.5 |

For several years prior to 1906 practically all of the coal used in the manufacture of coke in Colorado and Utah was slack, a large proportion of which was washed before being charged into the ovens. In 1906 there were 708,306 tons of run-of-mine coal used, of which

703,440 tons were washed. In 1907 the run-of-mine coal used amounted to 679,182 tons, of which 676,226 tons were washed. The slack coal used in 1907 amounted to 1,709,729 tons, of which 654,540 tons were washed and 1,055,189 unwashed.

The character of the coal used in the manufacture of coke in Colorado and Utah in 1890, 1895, 1900, and from 1903 to 1907 is shown in the following table:

*Character of coal used in the manufacture of coke in Colorado and Utah, 1890–1907.*

| Year. | Run-of-mine. |  | Slack. |  | Total. |
|---|---|---|---|---|---|
|  | Unwashed. | Washed. | Unwashed. | Washed. |  |
| 1890 | 36,058 | 0 | 395,023 | 0 | 431,081 |
| 1895 | 119,868 | 0 | 453,597 | 7,119 | 580,584 |
| 1900 | 229,311 | 0 | 316,527 | 452,023 | 997,861 |
| 1903 | 0 | 0 | 594,584 | 1,182,390 | 1,776,974 |
| 1904 | 400 | 0 | 745,450 | 630,504 | 1,376,354 |
| 1905 | 0 | 0 | 691,982 | 1,676,383 | 2,368,365 |
| 1906 | 4,866 | 703,440 | 1,065,353 | 792,537 | 2,566,196 |
| 1907 | 2,956 | 676,226 | 1,055,189 | 654,540 | 2,388,911 |

## GEORGIA.

Dade County, in the extreme northwestern corner of Georgia, contains a small area of the Walden Ridge (Tennessee) coal basin, and a portion of the adjoining county of Walker is underlain by an extension of the Lookout Mountain beds of Alabama. Coal mining on quite an extensive scale is carried on in both counties, and a good grade of coke is made from the slack coal produced in mining. The iron furnaces in and near Chattanooga, Tenn., supply the principal market for the coke. All of the coal used in coking was washed before being charged into the ovens.

The coke production of Georgia in 1907 amounted to 74,934 short tons, valued at $315,371, against 70,280 short tons, valued at $277,921 in 1906, indicating an increase in quantity of 4,654 tons, or 6.62 per cent, and of $37,450 or 13.5 per cent in value. The average price per ton was advanced from $2.81 in 1904 to $3.18 in 1905, to $3.95 in 1906, and to $4.21 in 1907. There are only two establishments in the State, both of which have been in operation since 1900, though 50 ovens of one establishment were idle during November and December of 1907, following the depression in the iron trade.

The statistics of coke production in Georgia in 1880, 1890, 1900, and from 1903 to 1907 are shown in the following table·

*Statistics of the manufacture of coke in Georgia, 1880–1907*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 1 | 140 | 40 | 63,402 | 38,041 | $81,789 | $2.15 | 60 |
| 1890 | 1 | 300 | 0 | 170,388 | 102,233 | 150,995 | 1.48 | 60 |
| 1900 | 2 | 480 | 0 | 140,988 | 73,928 | 210,646 | 2.85 | 52.4 |
| 1903 | 2 | 500 | 0 | 146,086 | 85,546 | 368,351 | 4.31 | 58.5 |
| 1904 | 2 | 500 | 0 | 132,270 | 75,812 | 212,697 | 2.81 | 57.3 |
| 1905 | 2 | 533 | 0 | 119,036 | 70,593 | 224,260 | 3.18 | 59.3 |
| 1906 | 2 | 531 | 0 | 128,052 | 70,280 | 277,921 | 3.95 | 54.9 |
| 1907 | 2 | 350 | 0 | 136,031 | 74,934 | 315,371 | 4.21 | 55.1 |

## ILLINOIS.

The operations of the 160 Semet-Solvay ovens at South Chicago, mention of which was made in the report for 1906, have given Illinois some prominence as a coke-manufacturing State, although the coal used is drawn from the mines of Fayette County, West Virginia, and not from the mines of Illinois. In 1907 Illinois ranked tenth among the coke-producing States, with a total output of 372,697 short tons, valued at $1,737,464, against 268,693 short tons, valued at $1,205,462, in 1906, and 10,307 tons, valued at $27,681, in 1905. There was one other plant besides the Semet-Solvay ovens at South Chicago which produced coke in 1907. This was the Gallatin Coal and Coke Company at Equality, which made coke in Belgian ovens from Illinois coal. There were at the close of the year 280 Koppers regenerative by-product ovens under construction at Joliet by the Illinois Steel Company. It is anticipated that these ovens will be completed and in operation before the close of 1908.

The statistics of the manufacture of coke in Illinois during the last four years are shown in the following table:

*Statistics of the manufacture of coke in Illinois, 1904–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1904 | 5 | 155 | 120 | 8,131 | 4,439 | $9,933 | $2.24 | 54.6 |
| 1905 | 5 | 275 | 0 | 16,821 | 10,307 | 27,681 | 2.685 | 61.3 |
| 1906 | 4 | 309 | 0 | 362,163 | 268,693 | 1,205,462 | 4.48 | 74.2 |
| 1907 | 5 | [a] 309 | [b] 280 | 514,983 | 372,697 | 1,737,464 | 4.66 | 72.3 |

[a] Includes 160 Semet-Solvay ovens.

[b] Koppers regenerative by-product ovens.

## KANSAS.

The coking industry of Kansas is of comparatively small importance and depends for its existence upon the limited demand of the zinc smelters, which do not require a high grade of coke. In fact, all of the coke made in the State is at ovens operated in connection with the zinc works, the coal being slack obtained from the mines in the vicinity of Pittsburg, and all of which is used unwashed. The plant of 50 ovens at Cokedale has not been in operation during the last four or five years. There were 6 establishments with a total of 83 ovens, all of which made coke in 1907, except the plant at Cokedale. One of the establishments consisting of 10 ovens made coke in the early part of the year but was abandoned in November. The production of the State, which had decreased steadily from 20,902 tons in 1902 until in 1906 it amounted to only 1,698 tons, increased to 6,274 tons in 1907.

The production in 1890, 1900, and since 1903 has been as follows:

*Statistics of the manufacture of coke in Kansas, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke ot ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 2 | 6 | 0 | 4,800 | 3,070 | $6,000 | $1.95 | 64 |
| 1890 | 7 | 68 | 0 | 21,809 | 12,311 | 29,116 | 2.37 | 56 |
| 1900 | 9 | 91 | 0 | 10,303 | 5,948 | 14,985 | 2.52 | 57.7 |
| 1903 | 9 | 91 | 0 | 30,503 | 14,194 | 50,221 | 3.54 | 46.5 |
| 1904 | 6 | 91 | 0 | 14,525 | 9,460 | 23,485 | 2.48 | 65 |
| 1905 | 6 | 91 | 0 | 6,504 | 4,425 | 13,818 | 3.12 | 68 |
| 1906 | 5 | 81 | 0 | 2,807 | 1,698 | 4,101 | 2.42 | 60.5 |
| 1907 | 6 | 83 | 0 | 11,392 | 6,274 | 19,837 | 3.16 | 55 |

## KENTUCKY.

Kentucky is the only one of the United States whose coal supplies are drawn from any two of the great fields. The eastern counties of the State are underlain by the coal measures of the Appalachian system, while the southern extremity of the Eastern Interior or Illinois-Indiana field is worked extensively in the western part of Kentucky. Coke is made from coal mined in both the eastern and the western parts of the State, and although the coals of the eastern counties are in large part included among the coking coals of the Appalachian field, and although little or no coke is made from the coals of the Eastern Interior field in Illinois or Indiana, more than half of Kentucky's coke output is made in the western part of the State.

There are 6 coking establishments in Kentucky, 4 of which made coke in 1906 and 1907, the same plants being idle in both years. The 2 idle plants consist of 54 ovens. One establishment of 200 ovens was idle during the greater part of the year, and the production decreased from 74,064 tons in 1906 to 67,068 tons in 1907. The value decreased from $169,846 in 1906 to $157,288 in 1907. The average price per ton advanced from $2.29 in 1906 to $2.35 in 1907.

The production of coke in Kentucky in 1880, 1890, 1900, and from 1903 to 1907 is shown in the following table:

*Statistics of the manufacture of coke in Kentucky, 1880-1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 5 | 45 | 0 | 7,206 | 4,250 | $12,250 | $2.88 | 59 |
| 1890 | 9 | 175 | 103 | 24,372 | 12,343 | 22,191 | 1.80 | 51 |
| 1900 | 5 | 458 | 3 | 190,268 | 95,532 | 235,505 | 2.47 | 50.2 |
| 1903 | 7 | 499 | 0 | 247,950 | 115,362 | 305,327 | 2.65 | 46.5 |
| 1904 | 7 | 499 | 0 | 140,139 | 64,112 | 138,226 | 2.15 | 45.7 |
| 1905 | 6 | 495 | 0 | 154,783 | 79,487 | 159,659 | 2.01 | 51.4 |
| 1906 | 6 | 462 | 0 | 148,448 | 74,064 | 169,846 | 2.29 | 49.9 |
| 1907 | 6 | 495 | 0 | 129,538 | 67,068 | 157,288 | 2.35 | 51.7 |

## MISSOURI.

Coke making in Missouri has never been much of an industry, and, as in Kansas, has been limited to the coking of a small quantity of Pittsburg (Kansas) slack, the coke being used at the zinc smelters in connection with which the ovens were operated. One of the two small plants with which the State has been credited during the last five years was abandoned in 1907, and the other one was idle in 1906 and 1907.

The statistics of production for a series of years has been as follows:

*Statistics of the manufacture of coke in Missouri, 1887–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1887 | 1 | 4 | 0 | 5,400 | 2,970 | $10,395 | $3.50 | 55 |
| 1890 | 3 | 10 | 0 | 9,491 | 6,136 | 9,240 | 1.51 | 65 |
| 1900 | 3 | 10 | 0 | 3,775 | 2,087 | 5,268 | 2.52 | 55.3 |
| 1903 | 2 | 8 | 0 | 3,004 | 1,839 | 5,797 | 3.15 | 61.2 |
| 1904 | 2 | 8 | 0 | 3,815 | 2,446 | 6,115 | 2.50 | 64 |
| 1905 | 2 | 6 | 0 | 2,551 | 1,580 | 4,072 | 2.58 | 61.9 |
| 1906 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1907 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |

## MONTANA.

One new establishment was added to the coke-manufacturing plants of Montana in 1907, increasing the number from 4 to 5. There was, however, no production at the new establishment, not being entirely completed before the end of the year, and two of the other plants, with a total of 100 ovens each, were also idle throughout the year. The entire production amounted to 40,714 tons, valued at $295,174, an increase of 2,532 tons in quantity and $29,150 in value over the production of 1906, when it amounted to 38,182 tons valued at $266,024. The average price per ton advanced from $6.97 in 1906 to $7.25 in 1907. A considerable advance is noted in the percentage yield of coal in coke in 1906 and 1907, while the yield reported in 1905 was low as compared with the two preceding years. The low percentage in 1905 was probably due to the fact that in that year the weight of the coal used was given before washing, while in other years the weight of the washed coal is reported. The higher yield in 1907, as compared with 1906, indicates a better separation of the impurities by washing. The quantity of coal used in 1907 was less than that used in 1904, while the production of coke was greater. All of the coal used for coke making in Montana is mine run, and nearly all of this is washed before being charged into the ovens.

The statistics of the manufacture of coke in Montana in 1884, when production was first reported, and for the years 1890, 1900, and since 1903 have been as follows:

*Statistics of the manufacture of coke in Montana, 1884–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1884 | 3 | 5 | 12 | 165 | 75 | $900 | $12.00 | 46 |
| 1890 | 2 | 140 | 0 | 32,148 | 14,427 | 125,655 | 8.71 | 45 |
| 1900 | 3 | 342 | 111 | 108,710 | 54,731 | 337,079 | 6.16 | 50.3 |
| 1903 | 4 | 555 | 0 | 82,118 | 45,107 | 310,882 | 6,89 | 54.9 |
| 1904 | 4 | 520 | 0 | 78,303 | 41,497 | 280,745 | 6.77 | 53 |
| 1905 | 4 | 555 | 100 | 68,777 | 31,482 | 211,351 | 6.71 | 45.8 |
| 1906 | 4 | 555 | 100 | 69,045 | 38,182 | 266,024 | 6.97 | 55.3 |
| 1907 | 5 | 567 | 15 | 68.948 | 40,714 | 295,174 | 7.25 | 59 |

## NEW MEXICO.

New Mexico is assuming considerable importance as a coke producer, the advance made during the last three years being particularly noticeable. In 1903 there were only 2 establishments in the Territory with a total of 126 ovens, and the production in that year amounted to 11,050 tons. In 1904 the number of establishments had increased to 3 with a total of 234 ovens, and the production amounted to 58,259 tons. In 1905 the same number of establishments reported 258 ovens completed, with 498 building, and the production amounted to 89,638 tons. In 1906, 4 establishments with a total of 571 completed ovens and 450 building produced 147,747 tons. Three hundred and twenty-five of the ovens building in 1906 were completed in 1907, increasing the total number of completed ovens to 896, and the production of coke increased to 265,125 tons. This increase in 1907 advances the Territory from sixteenth to fifteenth place in the rank of coke-producing States and Territories, and gave

New Mexico the largest percentage of increase of any State or Territory during 1907 over 1906 with the exception of Kansas. In the latter State the production was insignificant in either year. The increase of New Mexico's coke production in 1907 over 1906 was 117,378 tons or 79.45 per cent in quantity, and $397,541 or 89.8 per cent in value. The average price per ton increased from $3 in 1906 to $3.17 in 1907. One of the establishments in the Territory, having a bank of 50 ovens, was idle during 1907. With the exception of 2,498 tons, all of the coal used in the coke ovens of New Mexico in 1907 was washed slack.

The statistics of production in 1882, 1890, 1900, and from 1903 to 1907 are shown in the following table:

*Statistics of the manufacture of coke in New Mexico, 1882–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1882 | 2 | 0 | 12 | 1,500 | 1,000 | $6,000 | $6.00 | 66 |
| 1890 | 2 | 70 | 0 | 3,980 | 2,050 | 10,025 | 4.89 | 51.5 |
| 1900 | 2 | 126 | 0 | 74,261 | 44,774 | 130,251 | 2.91 | 60.3 |
| 1903 | 2 | 126 | 0 | 18,613 | 11,050 | 31,539 | 2.85 | 59.4 |
| 1904 | 3 | 234 | 0 | 94,397 | 58,259 | 171,976 | 2.95 | 61.7 |
| 1905 | 3 | 258 | 498 | 148,469 | 89,638 | 253,229 | 2.83 | 60.4 |
| 1906 | 4 | 571 | 450 | 261,609 | 147,747 | 442,712 | 3.00 | 56.5 |
| 1907 | 4 | 896 | 125 | 446,140 | 265,125 | 840,253 | 3.17 | 59.4 |

## OHIO.

Although Ohio ranks fourth in importance among the coal-producing States, it has not developed much prominence as a coke producer. This is in part due to the fact that much of the coal mined in the State makes an excellent blast-furnace fuel in its raw state and also to the proximity of the higher grade coking coals of Pennsylvania and West Virginia. The operations of the Rothberg by-product recovery plant at Cleveland, which was in full blast in 1905, 1906, and 1907, and the Otto-Hoffmann plant at Hamilton (near Cincinnati), together with an increased production of beehive coke at Leetonia, has, however, brought the total production for the State during the last three years up to considerable importance, although the quantity produced in 1907 was less than that reported in 1906.

The production in 1907 amounted to 270,634 short tons, valued at $819,262, as compared with 293,994 tons valued at $1,013,248 in 1906. The Otto-Hoffmann plant at Hamilton was not in operation from July 6 to December 10, owing to damages occasioned by a storm, and to this fact was probably due the slight falling off in the production for 1907. To Ohio is given the distinction of being the only State in which there was a decline in the average price of coke in 1907 as compared with 1906. The average price declined from $3.45 in 1906 to $3.03 in 1907. Of the 8 establishments in the State, one, with 120 ovens, was idle in 1907. This plant has been idle for the last three years.

The statistics of the production of coke in Ohio in 1880, 1890, 1900, and for the last five years are shown in the following table:

*Statistics of the manufacture of coke in Ohio, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 15 | 616 | 25 | 172,453 | 100,596 | $255,905 | $2.54 | 58 |
| 1890 | 13 | 443 | 1 | 126,921 | 74,633 | 218,090 | 2.92 | 59 |
| 1900 | 8 | 369 | 50 | 115,269 | 72,116 | 194,042 | 2.69 | 62.5 |
| 1903 | 8 | 440 | [a] 66 | 211,473 | 143,913 | 528,142 | 3.67 | 68 |
| 1904 | 8 | 539 | [a] 14 | 165,487 | 109,284 | 337,606 | 3.09 | 66 |
| 1905 | 8 | 573 | 0 | 396,961 | 277,130 | 970,897 | 3.50 | 69.8 |
| 1906 | 8 | 575 | 0 | 437,567 | 293,994 | 1,013,248 | 3.45 | 67.2 |
| 1907 | 8 | [a] 600 | [b] 50 | 376,759 | 270,634 | 819,262 | 3.03 | 71.8 |

[a] Includes 105 Rothberg and 50 United Otto ovens.

[b] United Otto ovens.

The larger part of the coal used in coke making in Ohio is unwashed run of mine, though in 1907 there was a larger proportion of washed coal used than in previous years. The Otto-Hoffmann plant at Hamilton, which formerly used run of mine unwashed coal, reported washing the coal before coking in 1907. Of the slack coal used in 1907 36,514 tons were unwashed and 25,896 tons washed. The washing of the run of mine coal at Hamilton is probably partly responsible for the increased yield of coal in coke, the percentage yield having increased from 67.2 in 1906 to 71.8 in 1907.

The character of the coal used in the manufacture of coke in Ohio in 1890, 1895, 1900, and from 1903 to 1907 is shown in the following table:

*Character of coal used in the manufacture of coke in Ohio since 1890, in short tons.*

| Year. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 34,729 | 0 | 54,473 | 37,719 | 126,921 |
| 1895 | 28,053 | 0 | 10,868 | 13,000 | 51,921 |
| 1900 | 68,175 | 0 | 17,094 | 30,000 | 115,269 |
| 1903 | 174,544 | 0 | 9,216 | 27,713 | 211,473 |
| 1904 | 140,915 | 0 | 7,249 | 17,323 | 165,487 |
| 1905 | 348,502 | 0 | 10,837 | 37,622 | 396,961 |
| 1906 | 356,540 | 0 | 38,737 | 42,290 | 437,567 |
| 1907 | 268,637 | 45,712 | 36,514 | 25,896 | 376,759 |

## OKLAHOMA.

Coke making in Oklahoma (Indian Territory) showed a decided falling off in 1907 as compared with 1906, and in 1906 the output was less than in 1905. The production for the last three years has been, respectively—1905, 54,781 tons; 1906, 49,782 tons; 1907, 19,089 tons. The decrease in the coke production was due principally to the extraordinary demand for coal which prevailed during 1907, the ovens being operated chiefly to utilize the slack used in the coal mining operations, and on account of the unusual demand for coal of all kinds in 1907 there was less surplus slack for coke making.

There are 5 coke making establishments in the State, of which three were operated in 1907. The 100 ovens at Howe have not been in operation for several years, and the 50 ovens at Alderson were also idle in 1907. In sympathy with the demand at advanced prices for coal in 1907, the average price for coke rose to $4.32 from $4.10 in 1906.

The statistics of the manufacture of coke in Oklahoma (Indian Territory) in 1880, 1890, 1900, and during the last 5 years are shown in the following table:

*Statistics of the manufacture of coke in Oklahoma (Indian Territory) 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 1 | 20 | 0 | 2,494 | 1,546 | $4,638 | $3.00 | 62 |
| 1890 | 1 | 80 | 0 | 13,278 | 6,639 | 21,577 | 3.25 | 50 |
| 1900 | 3 | 230 | 0 | 79,534 | 38,141 | 152,204 | 3.99 | 48 |
| 1903 | 5 | 286 | 0 | 110,088 | 49,818 | 227,542 | 4.57 | 45 |
| 1904 | 5 | 286 | 0 | 98,847 | 44,808 | 209,165 | 4.67 | 45.3 |
| 1905 | 5 | 388 | 50 | 123,389 | 54,781 | 199,424 | 3.64 | 44.4 |
| 1906 | 5 | 490 | 0 | 95,296 | 49,782 | 204,205 | 4.10 | 52.2 |
| 1907 | 5 | 490 | 50 | 38,615 | 19,089 | 82,447 | 4.32 | 49.4 |

All of the ovens in Oklahoma are of the standard beehive type and, as stated, are constructed for the purpose of utilizing slack coal produced in the mining operations, and for which there is usually little or no demand. In 1906, when the demand for coal was comparatively light, more than half the coal used in coke making was run of mine unwashed, while in 1907, with the heavier demand for coal, no run of mine was used for coke making, and all of the slack coal used was reported as washed.

The character of the coal used in the manufacture of coke in 1890, 1900, and since 1903 has been as follows:

*Character of coal used in the manufacture of coke in Oklahoma (Indian Territory) 1890–1907, in short tons.*

| Year. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 0 | 0 | 0 | 13,278 | 13,278 |
| 1900 | 0 | 0 | 20,832 | 58,702 | 79,534 |
| 1903 | 331 | 0 | 1,295 | 108,462 | 110,088 |
| 1904 | 0 | 0 | 59,760 | 39,087 | 98,847 |
| 1905 | 21,891 | 0 | 49,407 | 52,091 | 123,389 |
| 1906 | 50,802 | 0 | 0 | 44,494 | 95,296 |
| 1907 | 0 | 0 | 38,615 | 0 | 38,615 |

## PENNSYLVANIA.

Pennsylvania in the manufacture of coke, as in the mining of coal, far outranks the other States, and for more than a quarter of a century has contributed over 50 per cent of the total coke product of the United States. In 1907 Pennsylvania produced 65.02 per cent of the total coke output of the United States. Until the last year from 55 to 60 per cent of the total coke production of the State has come from the famous Connellsville district, contained in Fayette and Westmoreland counties, but in 1907 the percentage of this district to the total for the State was a little less than 50. This was not due to any falling off in the Connellsville district, but rather to an increased production in some of the other districts, particularly the Lower Connellsville or Klondike district. The Lower Connellsville district is located in Fayette County, and is separated from the Connellsville Basin proper by the Greensburg anticline. The Upper Connellsville or Latrobe district is the northern extremity of the Connellsville trough or basin.

If to the production of the Connellsville district proper is added that of the Upper and Lower Connellsville districts, the combined output represents 77.06 per cent of the total production of the State, and 50.1 per cent of the total output in the United States.

The quantity of coke produced in Pennsylvania in 1907 was 26,513,214 short tons, out of a total for the United States of 40,779,564 tons. In 1906 Pennsylvania produced 23,060,511 short tons out of a total of 36,401,217 short tons; in 1905 this State contributed 20,573,736 tons out of a total of 32,231,129 tons. Out of these totals the Connellsville district produced in 1907 13,089,427 tons, in 1906 12,057,840 tons, and in 1905 11,365,077 tons. Including the Lower and Upper Connellsville districts, the production for this entire region for these years was, respectively, 20,430,587 tons in 1907, 18,257,204 tons in 1906, and 15,992,333 in 1905. Compared with 1906 the total production of Pennsylvania in 1907 showed an increase of 3,452,703 tons, or 14.97 per cent. In the report for 1906 it was stated that that year was the most satisfactory in the history of the Pennsylvania coke trade, but in this respect 1907 showed an improvement over the preceding year. The production in 1907 was the largest ever made, and prices were still further advanced over those of 1906, which had been the highest in recent years with the exception of 1903, when, because of the coal shortage due to the strike in the anthracite region, coke prices were abnormally advanced. In 1907, with no such abnormal conditions, the average price of coke made in Pennsylvania exceeded that of the record made in 1903. There was scarcely a time during 1907, until the effects of the financial troubles were felt, that the production was in excess of the demand. There was hardly even any of the usual summer idleness, and, as transportation facilities showed also an improvement over 1906 and the immediately preceding years, operators were able to market their product without serious delay from lack of car supply or other deficiencies in transportation.

The total value of the coke product of Pennsylvania in 1907 was $67,638,024, against $54,184,531 in 1906, showing a gain of $13,453,493, or 24.83 per cent, as compared with the increase of 14.97 per cent in tonnage. The increase in value of 1907 over 1906 was more than 50 per cent of the total value of the coke produced in Pennsylvania in 1904, only three years before.

The average price obtained for coke made in Pennsylvania in 1907 was $2.55 as compared with $2.35 in 1906 and $2.05 in 1905. The price in 1907 was the highest reported in recent years. The percentage yield of coal in coke was 66.7 as compared with 66.8 in 1906, and while the percentage was less in 1907 than in 1906, it was above the average for recent years.

The quantity of coal consumed in the manufacture of coke in Pennsylvania in 1907 was 39,733,177 short tons, valued at $42,732,546 and represented 26.4 per cent of the total production of bituminous coal in the State during the year. In 1906 the consumption of coal for coke making was 34,503,513 short tons (26.7 per cent of the State's total bituminous coal product), valued at $35,395,374. The difference between the value of the coke and the coal from which it was made in 1907 was $24,905,478, or 58.3 per cent, while in 1906 the difference was $18,789,157, or 53 per cent. In 1905 the difference between the value of the coke and the value of the coal was $12,516,374, or 42 per cent. Coke prices were low in 1904, particularly as compared with the price of coal, and the difference in that year was only $3,568,206, or 16.6 per cent. In 1903, on the other hand, when coke prices were abnormally inflated by the scarcity of anthracite fuel, the difference between the coal and the coke values was nearly 60 per cent.

The number of coke-making establishments increased from 239 to 253, and the number of completed ovens increased from 47,185 to 51,364, a gain of 4,179. There were 1,337 ovens building at the close of 1907, as compared with 2,373 at the end of 1906. The completed ovens included 405 Semet-Solvay and 934 United Otto by-product recovery ovens, a total of 1,339 against a total of 1,232 by-product ovens in 1906.

The statistics of the production of coke in Pennsylvania for the years 1880, 1890, 1900, and for the last five years are shown in the following table:

*Statistics of the manufacture of coke in Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 124 | 9,501 | 836 | 4,347,558 | 2,821,384 | $5,255,040 | $1.86 | 65 |
| 1890 | 106 | 23,430 | 74 | 13,046,143 | 8,560,245 | 16,333,674 | 1.91 | 65.6 |
| 1900 | 177 | 32,548 | 2,310 | 20,239,966 | 13,357,295 | 29,692,258 | 2.22 | 66 |
| 1903 | 212 | 40,239 | 1,785 | 23,724,207 | 15,650,932 | 38,969,101 | 2.49 | 65.9 |
| 1904 | 217 | 42,165 | 1,621 | 22,432,064 | 14,861,064 | 25,027,462 | 1.68 | 66.2 |
| 1905 | 226 | 42,608 | 2,384 | 31,030,345 | 20,573,736 | 42,253,178 | 2.05 | 66.3 |
| 1906 | 239 | 47,185 | 2,373 | 34,503,513 | 23,060,511 | 54,184,531 | 2.35 | 66.8 |
| 1907 | 253 | [a]51,364 | 1,337 | 39,733,177 | 26,513,214 | 67,638,024 | 2.55 | 66.7 |

[a] Includes 934 United Otto and 405 Semet-Solvay ovens.

The character of the coal used in the manufacture of coke in Pennsylvania in 1890, 1895, 1900, and from 1903 to 1907 has been as follows:

*Character of the coal used in the manufacture of coke in Pennsylvania since 1890, in short tons.*

| Year. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 11,788,625 | 303,591 | 630,195 | 323,732 | 13,046,143 |
| 1895 | 13,618,376 | 34,728 | 440,869 | 117,594 | 14,211,567 |
| 1900 | 17,692,623 | 647,045 | 1,300,796 | 599,502 | 20,239,966 |
| 1903 | 20,297,033 | 644,441 | 1,981,544 | 801,189 | 23,724,207 |
| 1904 | 19,447,395 | 697,771 | 1,340,474 | 946,424 | 22,432,064 |
| 1905 | 26,148,696 | 1,335,631 | 2,436,621 | 1,109,397 | 31,030,345 |
| 1906 | 27,471,566 | 3,972,712 | 1,584,152 | 1,475,083 | 34,503,513 |
| 1907 | 33,589,751 | 2,267,142 | 2,566,090 | 1,310,194 | 39,733,177 |

## PRODUCTION BY DISTRICTS.

In previous chapters of this series it has been customary to consider the production of coke in Pennsylvania according to certain well-defined districts. These divisions are based to some extent upon geographic boundaries, but also upon the quality of the coal mined and the coke produced. Each one has been more fully described in some of the preceding volumes, but the following brief statement regarding the territory included in the different coking districts is repeated here for the sake of convenience.

The Allegheny Mountain district includes the ovens along the line of the Pennsylvania Railroad from Gallitzin eastward over the crest of the Alleghenies to beyond Altoona. The Allegheny Valley district formerly included the coke works of Armstrong and Butler counties and one of those in Clarion County, the other ovens in the latter county being included in the Reynoldsville-Walston district. All but two of the Allegheny Valley plants have been abandoned, and the production of these establishments has for the last few years been included in that of the Pittsburg district. What was previously known as the Beaver district included the ovens in Beaver and Mercer counties, but all the ovens in Beaver County have been abandoned, and the operations of the Semet-Solvay ovens in Mercer County are also now included in the Pittsburg district. The Blossburg and Broadtop districts embrace the Blossburg and Broadtop coal fields. The ovens of the Clearfield-Center district are chiefly in the two counties from which it derives its name. A few ovens constructed recently in Elk County have been included in the Clearfield-Center district. The Connellsville district is the well-known region of western Pennsylvania in Westmoreland and Fayette counties, extending from just south of Latrobe to Fairchance. The Lower Connellsville region is entirely in Fayette County and southwest of the Connellsville basin proper, from which it is separated by the Greensburg anticline. It embraces the recent developments in the vicinity of Uniontown, and is now the second producing district of the State. The Greensburg, Irwin, Pittsburg, and Reynoldsville-Walston districts include the ovens near the towns which have given the names to these districts. The Upper Connellsville district, sometimes called the Latrobe district, is near the town of Latrobe. The Semet-Solvay ovens at Chester, Steelton, and Lebanon, and the United Otto ovens at Lebanon are in what has been designated as the Lebanon-Schuylkill district, the production of which has been combined with that of the Broadtop district.

The statistics of the manufacture of coke in Pennsylvania by districts, in 1906 and 1907, are presented in the following tables:

*Coke production in Pennsylvania in 1906 and 1907, by districts.*

1906.

| District. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| Allegheny Mountain | 16 | [a]2,137 | [b]137 | 1,271,710 | 893,271 | $2,552,967 | $2.85 | 70.2 |
| Allegheny Valley [c] | 2 | 50 | 0 | ........ | ........ | ........ | ........ | ........ |
| Broadtop [d] | 5 | 584 | 0 | 978,893 | 710,143 | 2,824,343 | 3.98 | 72.5 |
| Clearfield-Center | 7 | 738 | 0 | 91,822 | 56,634 | 162,722 | 2.87 | 61.6 |
| Connellsville | 101 | [e]23,616 | 142 | 17,956,160 | 12,057,840 | 26,858,660 | 2.23 | 67.1 |
| Greensburg | 8 | 1,428 | 260 | 1,118,227 | 678,817 | 1,641,473 | 2.42 | 60.7 |
| Irwin | 5 | 581 | 0 | 348,007 | 230,552 | 510,572 | 2.21 | 66.2 |
| Lebanon and Schuylkill [d] | 4 | [f]507 | 0 | (d) | (d) | (d) | (d) | (d) |
| Lower Connellsville | 53 | 9,708 | 1,502 | 7,465,205 | 5,188,135 | 12,046,889 | 2.32 | 69.4 |
| Pittsburg [g] | 8 | [h]2,818 | 0 | 2,376,403 | 1,463,795 | 3,620,030 | 2.47 | 61.5 |
| Reynoldsville-Walston | 8 | 2,502 | 0 | 1,399,801 | 770,095 | 1,794,127 | 2.33 | 55.8 |
| Upper Connellsville | 22 | 2,516 | 332 | 1,497,285 | 1,011,229 | 2,172,748 | 2.15 | 67.5 |
| Total | 239 | 47,185 | 2,373 | 34,503,513 | 23,060,511 | 54,184,531 | 2.35 | 66.8 |

[a] Includes 260 Otto-Hoffmann ovens.

[b] Includes 112 Otto-Hoffmann ovens.

[c] Production included in Pittsburg district.

[d] Production in Lebanon and Schuylkill valleys included in Broadtop district.

[e] Includes 110 Semet-Solvay ovens.

[f] Includes 275 Semet-Solvay and 232 Otto-Hoffmann ovens.

[g] Includes production of ovens in Allegheny Valley district.

[h] Includes 330 Otto-Hoffmann and 25 Semet-Solvay ovens.

*Coke production in Pennsylvania in 1906 and 1907, by districts*—Continued.

1907.

| District. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| **Allegheny Mountain.** | 17 | [a] 2,424 | 0 | 1,753,002 | 1,209,592 | $3,564,117 | $2.95 | 69 |
| Allegheny Valley [b] | 2 | 50 | 0 | .......... | .......... | .......... | .......... | .......... |
| Broadtop [c] | 6 | 634 | 46 | 1,547,741 | 1,154,874 | 4,977,142 | 4.31 | 74.6 |
| Clearfield-Center | 7 | 706 | 0 | 115,388 | 74,187 | 191,378 | 2.58 | 64.3 |
| Connellsville | 101 | [d] 23,857 | 0 | 19,751,739 | 13,089,427 | 30,355,050 | 2.32 | 66.3 |
| Greensburg | 8 | 1,735 | 0 | 1,206,981 | 798,003 | 2,273,078 | 2.85 | 66.1 |
| Irwin | 5 | 572 | 0 | 315,601 | 210,393 | 492,304 | 2.34 | 66.7 |
| Lebanon and Schuylkill [c] | 4 | [e] 482 | 0 | .......... | .......... | .......... | .......... | .......... |
| Lower Connellsville | 62 | 12,264 | 1,068 | 9,150,693 | 6,310,900 | 15,758,049 | 2.50 | 69 |
| Pittsburg [f] | 10 | [g] 3,135 | 0 | 2,807,931 | 1,764,747 | 5,183,156 | 2.94 | 62.9 |
| Reynoldsville-Walston | 9 | 2,781 | 0 | 1,526,123 | 870,831 | 2,386,678 | 2.74 | 57.1 |
| Upper Connellsville | 22 | 2,724 | 223 | 1,557,978 | 1,030,260 | 2,457,072 | 2.38 | 66.1 |
| **Total** | 253 | 51,364 | 1,337 | 39,733,177 | 26,513,214 | 67,638,024 | 2.55 | 66.7 |

[a] Includes 372 United Otto and 152 Newton-Chambers ovens.
[b] Production included in Pittsburg district.
[c] Production of Lebanon and Schuylkill valleys included in Broadtop district.
[d] Includes 110 Semet-Solvay ovens.
[e] Includes 250 Semet-Solvay and 232 United Otto ovens.
[f] Includes production of ovens in Allegheny Valley district.
[g] Includes 330 United Otto and 25 Semet-Solvay ovens.

*Allegheny Mountain district.*—This district includes all of the coke ovens in the vicinity of Johnstown, Cambria County, and those lying along the line of the Pennsylvania Railroad in Indiana County. It also includes a few establishments in Somerset County. The plants in Cambria County include the Otto-Hoffmann by-product ovens at Johnstown, which are operated in connection with the iron and steel works of the Cambria Steel Company. This plant consisted originally of 60 ovens, built in 1895, since which time it has been three times enlarged—first, by 100 more ovens in March, 1899; the second enlargement, this time also of 100 ovens, was made in September, 1904, and the last, of 112 ovens, completed in February, 1907. The effects of this increased equipment is shown particularly by the gain in production of coke in this district in 1907, the output having increased from 893,271 short tons in 1906 to 1,209,592 short tons in 1907, a gain of 316,321 tons, or 35.4 per cent. The value of the product increased from $2,552,967 in 1906 to $3,564,117 in 1907, a gain of $1,011,150, or 39.6 per cent. The average price per ton, which increased from $2.09 in 1904 to $2.50 in 1905, and again to $2.85 in 1906, showed a further increase to $2.95 in 1907. There are 17 coke-making establishments in the district, with a total of 2,424 ovens, of which 2 establishments, with a total of 155 ovens, were idle throughout 1907.

The statistics of the manufacture of coke in the Allegheny Mountain district in 1880, 1890, 1900, and from 1903 to 1907 have been as follows:

*Statistics of the manufacture of coke in the Allegheny Mountain district of Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 8 | 291 | 0 | 201,345 | 127,525 | $289,929 | $2.27 | 63 |
| 1890 | 16 | 1,171 | 0 | 633,974 | 402,514 | 730,048 | 1.81 | 63.5 |
| 1900 | 14 | 1,341 | 0 | 876,440 | 557,184 | 1,260,441 | 2.26 | 63.6 |
| 1903 | 16 | [a] 2,047 | [b] 100 | 1,116,345 | 739,263 | 2,139,569 | 2.89 | 66.2 |
| 1904 | 17 | [c] 2,153 | 100 | 785,105 | 551,570 | 1,152,101 | 2.09 | 70.3 |
| 1905 | 17 | [c] 2,245 | [d] 142 | 1,406,540 | 967,042 | 2,421,799 | 2.50 | 68.7 |
| 1906 | 16 | [c] 2,137 | [d] 137 | 1,271,710 | 893,271 | 2,552,967 | 2.85 | 70.2 |
| 1907 | 17 | [e] 2,424 | 0 | 1,753,002 | 1,209,592 | 3,564,117 | 2.95 | 69 |

[a] Includes 160 Otto-Hoffmann ovens.

[b] Otto-Hoffmann ovens.

[c] Includes 260 Otto-Hoffmann ovens.

[d] Includes 112 Otto-Hoffmann ovens.

[e] Includes 372 United Otto and 152 Newton-Chambers ovens.

*Broadtop district.*—The Broadtop district includes the ovens in Bedford and Huntingdon counties, the coal for which is drawn from the Broadtop coal field. The number of establishments in this district was increased from 5 to 6 during 1907. All of the ovens were operated during 1907. There were 50 new ovens added to the district during 1907, increasing the total number from 584 to 634, and there were 46 ovens building at the close of 1907. The Semet-Solvay ovens at Lebanon, Chester, and Steelton, and the Otto-Hoffmann ovens at Lebanon, have been added to this district. This addition is responsible for the apparently large increase from 237,639 tons in 1904 to 483,198 tons in 1905; also for the larger increase from 710,143 tons in 1906 to 1,154,874 tons in 1907, a gain of 444,731 tons, or 62.6 per cent, with an increase in value from $2,824,343 to $4,977,142, a gain of $2,152,799, or 76.2 per cent. What has been stated in preceding pages regarding the high value of coke produced at by-product ovens is exemplified in the statistics in the following table, the large production of by-product coke making the total value for the Broadtop district $4.31 per ton, against $3.98 in 1906 and $3.20 in 1905. The highest price for coke obtained in any other district of Pennsylvania in 1907 was in the Allegheny Mountain district, where an average of $2.95 was obtained.

The statistics of the manufacture of coke in the Broadtop district, including the output of the by-product ovens at Lebanon, Chester, and Steelton, are shown in the following table:

*Statistics of the manufacture of coke in the Broadtop district, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 5 | 188 | 105 | 92,894 | 51,130 | $123,748 | $2.40 | 55 |
| 1890 | 5 | 482 | 16 | 247,823 | 157,208 | 314,416 | 2.00 | 63 |
| 1900 | 5 | 532 | 0 | 179,088 | 113,448 | 230,580 | 2.03 | 63. |
| 1903 [a] | 5 | 571 | 0 | 351,507 | 244,898 | 748,920 | 3.06 | 69.6 |
| 1904 [b] | 5 | 606 | 0 | 358,807 | 237,639 | 645,045 | 2.71 | 66.2 |
| 1905 [a] | 5 | 614 | 0 | 687,954 | 483,198 | 1,544,966 | 3.20 | 70.2 |
| 1906 [a] | 5 | 584 | 0 | 978,893 | 710,143 | 2,824,343 | 3.98 | 72.5 |
| 1907 [c] | 6 | 634 | 46 | 1,547,741 | 1,154,874 | 4,977,142 | 4.31 | 74.6 |

[a] Includes production and value of coke in by-product ovens at Lebanon.

[b] Includes production and value of coke in by-product ovens at Lebanon and Chester.

[c] Includes production and value of coke in by-product ovens at Steelton, Lebanon, and Chester.

*Clearfield-Center-Elk district.*—This district, as its name implies, includes ovens located in the three counties mentioned, i. e., Clearfield, Center, and Elk. The district is not of much importance, and while, owing to the unusual demand for coke, the production of 1907 exceeded that of 1906, the coking industry in the district is showing a declining tendency. The total number of establishments in the district is 7, with a total of 706 ovens. Of these 7 establishments, 2, with a total of 200 ovens, were idle during 1907, and 1 plant with 200 ovens made less than 4,000 tons of coke, and another of 106 ovens made only a little more than 1 ton per oven during 1907.

The statistics of production for the years 1880, 1890, 1900, and from 1903 to 1907 have been as follows:

*Statistics of the manufacture of coke in the Clearfield-Center-Elk district, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 1 | 0 | 0 | 200 | 100 | $200 | $2.00 | 50 |
| 1890 | 7 | 701 | 0 | 331.104 | 212,286 | 391.957 | 1.85 | 64 |
| 1900 | 7 | 568 | 0 | 212,196 | 134,828 | 283.592 | 2.10 | 63.5 |
| 1903 | 9 | 850 | 0 | 278,329 | 178,276 | 583.906 | 3.28 | 64 |
| 1904 | 9 | 828 | 0 | 61,564 | 35,931 | 79.746 | 2.22 | 58.4 |
| 1905 | 8 | 648 | 0 | 182,659 | 119,651 | 273,028 | 2.28 | 65.5 |
| 1906 | 7 | 738 | 0 | 91,822 | 56,634 | 162,722 | 2.87 | 61.6 |
| 1907 | 7 | 706 | 0 | 115,388 | 74,187 | 191.378 | 2.58 | 64.3 |

*Connellsville district.*—The Connellsville district of Pennsylvania is the largest coke-producing district in the world. The coal basin occupies a comparatively narrow synclinal trough, extending in a northeast-southwest direction nearly across the two counties of Fayette and Westmoreland, within the boundaries of which it is entirely contained. It lies a short distance east of the city of Pittsburg, and supplies the larger part of the fuel consumed in the iron and steel furnaces of Pittsburg and vicinity, the greatest iron-manufacturing center of the world. This district, until 1903, produced from 40 to 50 per cent of the total coke output of the United States, the smaller percentage during the last four years being due to the largely increased production from the Lower Connellsville or Klondike region, which lies entirely within Fayette County, and which is separated from the Connellsville basin proper by the Greensburg anticline. If to the Connellsville production is added that of the Lower Connellsville, the supremacy of the district has been more than maintained.

Connellsville coal is the ideal fuel for coking in beehive ovens, and it is probably to the success of the beehive practice in the Connellsville district that is due the prevalence of the beehive oven in coke manufacturing in the United States, manufacturers being lead by the idea that because beehive coke manufactured from Connellsville coal is the standard for furnace and foundry use, other coal should also be coked in beehive ovens, whereas many coals are found to give more satisfactory results in retort ovens. All but 110 of the 23,857 ovens in the Connellsville district at the close of 1907 were of the beehive type. The exception was a bank of Semet-Solvay ovens at Dunbar. Connellsville beehive coke is considered by some iron masters as without rival for blast furnace use, and is undoubtedly the standard by which all other blast furnace cokes are judged.

The production of coke in the Connellsville district during 1907 amounted to 13,089,427 short tons, valued at $30,355,050, against 12,057,840 short tons, valued at $26,858,660 in 1906, a gain in 1907 of 1,031,587 tons, or 8.6 per cent in quantity, and of $3,496,390, or 13.02 per cent in value. The combined production of the Connellsville and Lower Connellsville districts in 1907 amounted to 19,400,000 tons, an increase of about 2,200,000 tons over the preceding year. The average price for Connellsville coke for 1907 was $2.32, as against $2.23 in 1906 and $1.96 in 1905. The number of establishments in the Connellsville district in 1907 was the same as in 1906—101—but the number of ovens increased from 23,616 to 23,857. There were no ovens reported as building in this district at the close of 1907. Of the total number of establishments, 4 with a total of 191 ovens were idle throughout 1907.

In the following table are presented the statistics of the manufacture of coke in the Connellsville district in 1880, 1890, 1900, and from 1903 to 1907:

*Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 67 | 7,211 | 731 | 3,367,856 | 2,205,946 | $3,948,643 | $1.79 | 65.5 |
| 1890 | 28 | 15,865 | 30 | 9,748,449 | 6,464,156 | 11,537,370 | 1.94 | 66.3 |
| 1900 | 98 | [a] 20,981 | 686 | 14,946,659 | 10,020,907 | 22,383,432 | 2.23 | 67 |
| 1903 | 99 | [b] 22,563 | [c] 130 | 13,498,850 | 9,102,391 | 20,707,442 | 2.27 | 67.4 |
| 1904 | 101 | [d] 22,695 | 1,044 | 13,185,690 | 8,883,220 | 13,990,329 | 1.58 | 67.4 |
| 1905 | 100 | [d] 22,033 | 200 | 16,980,341 | 11,365,077 | 22,315,361 | 1.96 | 66.9 |
| 1906 | 101 | [d] 23,616 | 142 | 17,956,160 | 12,057,840 | 26,858,660 | 2.23 | 67.1 |
| 1907 | 101 | [d] 23,857 | 0 | 19,751,739 | 13,089,427 | 30,355,050 | 2.32 | 66.3 |

[a] Includes 50 Semet-Solvay by-product ovens.
[b] Includes 80 Semet-Solvay by-product ovens.
[c] Includes 30 Semet-Solvay by-product ovens.
[d] Includes 110 Semet-Solvay by-product ovens.

The following table, compiled by the Connellsville Courier, of Connellsville, Pa., shows the shipments of coke from the Connellsville region in 1906 and 1907, by months, in cars and tons, with the average number of cars shipped each working day in the month. These figures include coke made in the Upper and Lower Connellsville districts as well as in the Connellsville district proper. It will be noted that while in 1906 the production as given by the Courier was somewhat larger than that reported to the Geological Survey, the Survey's figures in 1907 are somewhat in excess of those reported by the Courier. According to the following table the shipments of coke from the Connellsville district (including the Upper and Lower Connellsville districts) was 19,029,058 short tons, while the production for these districts as reported to the Survey was 20,430,587 tons.

*Shipments of coke from the Connellsville region, including Upper and Lower Connellsville districts, in 1906 and 1907, by months.*

| Month. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Cars. | Daily average. | Short tons. | Cars. | Daily average. | Short tons. |
| January | 62,049 | 2,386 | 1,665,747 | 62,240 | 2,305 | 1,698,475 |
| February | 53,398 | 2,225 | 1,435,452 | 59,272 | 2,470 | 1,625,783 |
| March | 62,694 | 2,334 | 1,683,212 | 61,999 | 2,384 | 1,701,342 |
| April | 59,922 | 2,397 | 1,604,906 | 62,585 | 2,407 | 1,708,590 |
| May | 64,923 | 2,404 | 1,739,743 | 65,929 | 2,442 | 1,787,611 |
| June | 61,673 | 2,372 | 1,654,209 | 61,518 | 2,461 | 1,677,488 |
| July | 61,995 | 2,384 | 1,662,545 | 63,577 | 2,355 | 1,741,612 |
| August | 62,948 | 2,331 | 1,685,036 | 65,262 | 2,417 | 1,787,190 |
| September | 60,157 | 2,406 | 1,610,509 | 59,637 | 2,386 | 1,650,207 |
| October | 68,940 | 2,516 | 1,850,450 | 64,656 | 2,395 | 1,805,307 |
| November | 65,194 | 2,507 | 1,752,234 | 41,412 | 1,593 | 1,167,796 |
| December | 61,381 | 2,361 | 1,655,283 | 23,670 | 910 | 677,657 |
| Total | 745,274 | 2,385 | 19,999,326 | 691,757 | 2,210 | 19,029,058 |

The monthly shipments of coke from this region in the years 1903 to 1907, as reported by the Courier, are given in the following table:

*Monthly shipments of coke from the Connellsville region, 1903–1907, in short tons.*

| Month. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| January | 1,134,272 | 718,382 | 1,283,152 | 1,665,747 | 1,698,475 |
| February | 958,984 | 845,428 | 1,350,128 | 1,435,452 | 1,625,783 |
| March | 1,274,863 | 1,062,192 | 1,497,756 | 1,683,212 | 1,701,342 |
| April | 1,346,053 | 1,118,043 | 1,843,502 | 1,604,906 | 1,708,590 |
| May | 1,288,550 | 1,146,907 | 1,451,554 | 1,739,743 | 1,787,611 |
| June | 1,379.257 | 945,520 | 1,354,470 | 1,654,209 | 1,677,488 |
| July | 1,327,239 | 887,402 | 1,622,998 | 1,662,545 | 1,741,612 |
| August | 1,211,826 | 975,724 | 1,328,002 | 1,685,036 | 1,787,190 |
| September | 1,239,265 | 1,153,471 | 1,726,734 | 1,610,509 | 1,650,207 |
| October | 1,041,966 | 1,148,089 | 1,430,238 | 1,850,450 | 1,805,307 |
| November | 629,768 | 1,207,131 | 1,488,942 | 1,752,234 | 1,167,796 |
| December | 513,187 | 1,219,174 | 1,519,050 | 1,655,283 | 677,657 |
| Total | 13,345,230 | 12,427,463 | 17,896,526 | 19,999,326 | 19,029,058 |

The total shipments, in cars, for the last twenty years were as follows:

*Total and daily average shipments, in cars, 1888–1907.*

| Year. | Daily average. | Total cars. | Year. | Daily average. | Total cars. | Year. | Daily average. | Total cars. |
|---|---|---|---|---|---|---|---|---|
| 1888 | 905 | 282,441 | 1895 | 1,410 | 441,243 | 1902 | 1,986 | 624,198 |
| 1889 | 1,046 | 326,220 | 1896 | 920 | 289,137 | 1903 | 1,782 | 558,738 |
| 1890 | 1,147 | 355,070 | 1897 | 1,181 | 367,383 | 1904 | .1,623 | 510,759 |
| 1891 | 884 | 274,000 | 1898 | 1,415 | 441,249 | 1905 | 1,886 | 588,328 |
| 1892 | 1,106 | 347,012 | 1899 | 1,676 | 523,203 | 1906 | 2,385 | 745,274 |
| 1893 | 874 | 270,930 | 1900 | 1,619 | 504,410 | 1907 | 2,210 | 691,757 |
| 1894 | 900 | 281,677 | 1901 | 1,857 | 581,051 | | | |

The following table shows the prices for Connellsville furnace and foundry cokes, by months, during the years 1903 to 1907. The abnormally high prices reported for both grades of coke in 1902 and 1903 was due to the scarcity of fuel caused by the strike in the anthracite region and were for prompt delivery, and although these prices were quoted and were actually obtained for coke sold for prompt delivery, the net returns to the producers in 1902 and 1903 were not so large as in 1907, nearly all of the coke shipped in 1903 having been sold on contracts made months before, so that while it appears that prices for prompt delivery were quoted for furnace coke as high as $12 in 1902 and $7 in 1903, the average returns to the manufacturers was $2.28 in 1902 and $2.27 in 1903, whereas in 1907 the average price for the year of Connellsville coke was $2.32, the highest figure of which there is any record. The prices quoted in the following table are for strictly Connellsville coke as reported by The Iron Age. "Main line" and "outside" cokes are usually quoted from 15 to 25 cents below strict Connellsville:

*Prices of Connellsville furnace and foundry coke, 1903–1907, by months.*

| Month. | Furnace. | | | | | |
|---|---|---|---|---|---|---|
| | 1903. | | 1904. | 1905. | 1906. | 1907. |
| | Six months' contracts. | Prompt delivery. | | | | |
| Jan | $3.75 to $4.00 | $6.00 to $7.00 | $1.60 to $1.65 | $2.10 to $3.00 | $2.15 to $2.75 | $3.50 to $3.75 |
| Feb | 3.50 to 4.00 | 4.50 to 5.50 | 1.50 to 1.65 | 2.00 to 2.75 | 2.10 to 2.50 | 3.50 to 3.65 |
| Mar | 3.50 to 4.00 | 5.00 to 5.50 | 1.60 to 1.75 | 2.25 to 2.50 | 2.20 to 2.50 | 2.90 to 3.25 |
| Apr | 3.75 to 4.00 | 4.50 to 5.00 | 1.60 to 1.65 | 1.90 to 2.25 | 2.30 to 2.75 | 2.65 to 2.85 |
| May | 3.00 to 3.50 | 3.50 to 4.00 | 1.60 to 1.65 | 1.80 to 2.00 | 2.30 to 2.75 | 2.00 to 2.85 |
| June | 2.75 to 3.00 | 2.75 to 3.50 | 1.40 to 1.65 | 1.75 to 2.10 | 2.30 to 2.50 | 1.75 to 2.65 |
| July | 2.50 | 2.50 | 1.40 to 1.50 | 1.75 to 2.10 | 2.40 to 2.75 | 2.40 to 2.60 |
| Aug | 2.25 to 2.50 | 2.00 to 2.50 | 1.45 to 1.50 | 1.80 to 2.10 | 2.75 to 2.85 | 2.40 to 2.85 |
| Sept | 2.25 to 2.50 | 2.00 to 2.50 | 1.40 to 1.50 | 1.90 to 2.50 | 2.85 to 2.90 | 2.75 to 2.90 |
| Oct | 2.00 to 2.10 | 1.75 to 2.10 | 1.45 to 1.65 | 2.35 to 3.10 | 2.75 to 3.25 | 2.75 to 3.00 |
| Nov | | 1.65 to 2.00 | 1.75 to 2.15 | 2.85 to 3.00 | 3.00 to 3.60 | 2.00 to 2.75 |
| Dec | | 1.65 to 1.75 | 2.10 to 2.45 | 2.75 to 2.90 | 3.00 to 3.60 | 2.00 to 2.50 |

| Month. | Foundry. | | | | | |
|---|---|---|---|---|---|---|
| | 1903.[a] | 1903.[b] | 1904. | 1905. | 1906. | 1907. |
| Jan | $4.75 to $5.00 | $6.00 to $7.50 | $2.10 to $2.50 | $2.25 to $2.75 | $2.75 to $3.50 | $4.00 to $4.50 |
| Feb | (c) | 6.00 to 7.00 | 2.10 to 2.25 | 2.50 to 3.00 | 2.50 to 3.00 | 3.75 to 4.50 |
| Mar | (c) | 6.00 to 7.00 | 2.10 to 2.50 | 2.75 to 3.25 | 2.75 to 3.25 | 3.50 to 4.00 |
| Apr | 5.00 | 5.50 to 6.00 | 2.15 to 2.50 | 2.65 to 3.00 | 2.90 to 3.10 | 3.25 to 3.75 |
| May | 4.00 | 4.00 to 5.50 | 2.00 to 2.15 | 2.50 to 2.75 | 2.65 to 3.10 | 2.75 to 3.25 |
| June | 3.25 to 4.00 | 3.50 to 4.00 | 1.80 to 2.00 | 2.35 to 2.65 | 2.65 to 2.75 | 3.00 to 3.25 |
| July | 3.00 to 3.25 | 3.00 to 3.50 | 1.75 to 1.85 | 2.25 to 2.50 | 2.75 to 3.00 | 3.00 to 3.25 |
| Aug | 3.00 | 3.00 | 1.75 to 1.85 | 2.25 to 2.50 | 3.00 to 3.25 | 3.00 to 3.75 |
| Sept | 2.75 to 3.00 | 2.75 to 3.00 | 1.75 to 2.00 | 2.40 to 3.00 | 3.25 to 3.50 | 3.15 to 3.50 |
| Oct | 2.75 to 3.00 | 2.75 to 3.00 | 1.80 to 2.25 | 2.75 to 3.50 | 3.25 to 4.00 | 3.25 to 3.40 |
| Nov | | 2.50 to 2.65 | 2.00 to 2.50 | 3.50 to 4.00 | 3.75 to 4.50 | 2.50 to 3.00 |
| Dec | | 2.15 to 2.50 | 2.25 to 2.50 | 3.40 to 4.00 | 3.75 to 4.50 | 2.50 to 2.75 |

[a] Contract prices. [b] Prompt delivery. [c] No contract prices quoted.

*Greensburg district.*—The ovens in the Greensburg district are all located in the vicinity of the city of Greensburg. There are 8 establishments in the district, and there were, at the close of 1907, 1,735 ovens in the district, of which only 10 were idle throughout the year. The total production in 1907 amounted to 798,003 short tons, as against 678,817 tons in 1906 and 551,233 in 1905. The value increased from $1,155,958 in 1905 to $1,641,473 in 1906 and to $2,273,078 in 1907. The average price per ton advanced from $2.42 in 1906 to $2.85 in 1907.

The statistics of the manufacture of coke in the Greensburg district, Pennsylvania, in 1889, 1890, 1900, and from 1903 to 1907 are given in the following table:

*Statistics of the manufacture of coke in the Greensburg district, Pennsylvania, 1889–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1889 | 2 | 50 | 16 | 32,070 | 20,459 | $21,523 | $1.05 | 63.8 |
| 1890 | 2 | 58 | 0 | 44,000 | 30,261 | 44,290 | 1.46 | 68.7 |
| 1900 | 5 | 680 | 280 | 331,305 | 196,709 | 442,704 | 2.25 | 59.4 |
| 1903 | 7 | 1,332 | 0 | 813,216 | 451,385 | 1,477,134 | 3.27 | 55.5 |
| 1904 | 7 | 1,332 | 0 | 511,303 | 314,954 | 551,228 | 1.75 | 61.6 |
| 1905 | 7 | 1,328 | 100 | 908,003 | 551,233 | 1,155,958 | 2.10 | 60.7 |
| 1906 | 8 | 1,428 | 260 | 1,118,227 | 678,817 | 1,641,473 | 2.42 | 60.7 |
| 1907 | 8 | 1,735 | 0 | 1,206,981 | 798,003 | 2,273,078 | 2.85 | 66.1 |

*Irwin district.*—This district, which is of minor importance, includes 572 ovens, located near the town of Irwin in Westmoreland County. The production in 1907 was slightly less than that of 1906, the output declining from 230,552 short tons in 1906 to 210,393 tons in 1907, with a decrease from $510,572 to $492,304. In general sympathy with the advanced prices, however, the average price for coke in this district increased from $2.21 in 1906 to $2.34 in 1907. The Irwin district began manufacturing coke in 1889. The statistics of production in that year, in 1890, 1900, and from 1903 to 1907, have been as follows:

*Statistics of the manufacture of coke in the Irwin district, Pennsylvania, 1889–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1889 | 4 | 696 | 0 | 373,913 | 243,448 | $351,304 | $1.44 | 65 |
| 1890 | 4 | 661 | 0 | 270,476 | 172,329 | 256,458 | 1.49 | 63.7 |
| 1900 | 5 | 697 | 0 | 93,647 | 61,630 | 153,743 | 2.49 | 65.8 |
| 1903 | 6 | 691 | 0 | 207,067 | 133,290 | 334,434 | 2.51 | 64.4 |
| 1904 | 6 | 691 | 0 | 14,468 | 8,793 | 14,576 | 1.66 | 60.8 |
| 1905 | 5 | 680 | 27 | 258,039 | 164,601 | 325,746 | 1.98 | 63.8 |
| 1906 | 5 | 581 | 0 | 348,007 | 230,552 | 510,572 | 2.21 | 66.2 |
| 1907 | 5 | 572 | 0 | 315,601 | 210,393 | 492,304 | 2.34 | 66.7 |

*Lower Connellsville district.*—This district, sometimes called the "Klondike," is located in the western part of Fayette County, immediately west of the southern end of the Connellsville basin, from which it is separated by the Greensburg anticline. Although but 8 years old, having been opened in 1900, it ranks next to Connellsville among the coke-making districts in the United States, having in 1906 and 1907 produced more than 3 times the output of the Flat Top district in Virginia and West Virginia, which until 1902 was the second coke-producing region in the United States. The development of this district surpasses all records in the United States, and the production has grown with phenomenal rapidity. Following the abnormal conditions in 1904 the production of coke in Pennsylvania showed a decrease in every district except the Lower Connellsville, which showed an increase in 1904 over 1903 of 558,158 short tons, while the total production of the State decreased 789,868 tons. The record for 1905 showed an increase of nearly 1,000,000 tons over 1904, and 1906 showed a gain of 1,300,000 over 1905. The statistics for 1907 show a further increase of 1,122,765 tons or 21.7 per cent over 1906 with an increase in value of $3,711,160 or 30.8 per cent. The 62 coking establishments in the district include 3 incomplete at the close of 1907. There was a total of 12,264 ovens completed and

1 068 building. None of the establishments except those which were incomplete were idle during 1907.

The record of the district for the eight years of its existence has been as follows:

*Statistics of the manufacture of coke in the Lower Connellsville district, Pennsylvania, 1900–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1900 | 12 | 2,033 | 1,112 | 579,928 | 385,909 | $792,886 | $2.05 | 66.5 |
| 1901 | 17 | 3,251 | 30 | 1,666,826 | 1,116,379 | 1,991,699 | 1.78 | 66.9 |
| 1902 | 21 | 4,253 | 705 | 2,826,242 | 1,899,111 | 4,701,068 | 2.48 | 67.2 |
| 1903 | 32 | 5,753 | 786 | 3,452,568 | 2,329,298 | 5,522,884 | 2.37 | 67.5 |
| 1904 | 34 | 6,570 | 250 | 4,229,755 | 2,887,456 | 4,623,133 | 1.60 | 68.2 |
| 1905 | 45 | 7,484 | 1,145 | 5,666,812 | 3,871,310 | 7,532,382 | 1.95 | 68.3 |
| 1906 | 53 | 9,708 | 1,502 | 7,465,205 | 5,188,135 | 12,046,889 | 2.32 | 69.4 |
| 1907 | 62 | 12,264 | 1,068 | 9,150,693 | 6,310,900 | 15,758,049 | 2.50 | 69.0 |

*Lebanon Valley and Schuylkill districts.*—All of the by-product ovens in the Lebanon and Schuylkill valleys, which include 120 Semet-Solvay ovens at Steelton, 40 at Chester, 90 Semet-Solvay ovens at Lebanon, and 232 Otto-Hoffman ovens at Lebanon, were operated during 1907. The total production of these 4 plants in 1907 amounted to 909,188 short tons. In 1906, when the Semet-Solvay ovens at Chester and Steelton were not in operation, the production amounted to 559,601 short tons, and in 1905 the production was 297,716 short tons.

*Pittsburg district.*—A large part of the production of the Pittsburg district is from slack coal obtained from the mines along the slack-water navigation of the Monongahela River and is brought to Pittsburg on barges. Some run-of-mine coal is also brought from the fourth pool of the Monongahela River at Pittsburg. The production of 120 Otto-Hoffman ovens at Glassport and 25 Semet-Solvay ovens at Sharon, in Mercer County, is included in this district. The production in 1907 amounted to 1,764,747 short tons, valued at $5,183,156, against 1,463,795 short tons, valued at $3,620,030 in 1906, an increase of 300,952 tons or 20.6 per cent in quantity, and of $1,563,126 or 43.2 per cent in value. There are 12 establishments in the district with a total of 3,185 ovens. The only plant idle during 1907 was the Semet-Solvay plant of 25 ovens at Sharon.

The statistics of the manufacture of coke in the Pittsburg district for 1880, 1890, 1900, and from 1903 to 1907 are given in the following table:

*Statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 21 | 534 | 0 | 194,393 | 105,974 | $254,500 | $2.40 | 55 |
| 1890 | 14 | 541 | 0 | 149,230 | 93,984 | 171,465 | 1.82 | 63 |
| 1900 | 8 | 1,641 | 0 | 862,610 | 570,678 | 1,418,382 | 2.48 | 66.1 |
| 1903 [a] | 9 | 1,636 | 359 | 1,404,660 | 877,640 | 2,632,827 | 3.00 | 62.5 |
| 1904 [a] | 8 | 2,195 | 0 | 1,370,629 | 841,459 | 1,795,257 | 2.13 | 61.4 |
| 1905 [a] | 8 | 2,226 | 380 | 2,317,159 | 1,463,774 | 3,599,436 | 2.46 | 63.2 |
| 1906 [a] | 10 | 2,868 | 0 | 2,376,403 | 1,463,795 | 3,620,030 | 2.47 | 61.5 |
| 1907 [a] | [b] 12 | [c] 3,185 | 0 | 2,807,931 | 1,764,747 | 5,183,156 | 2.94 | 62.9 |

[a] Includes ovens and production in Allegheny Valley district.

[b] Includes 2 establishments in Mercer County, 1 in Beaver County, and 2 in Allegheny Valley district.

[c] Includes 330 United Otto and 25 Semet-Solvay ovens.

*Reynoldsville- Walston district.*—This district, in Jefferson and Clearfield counties, includes all of the ovens along the line of the Rochester and Pittsburg Railroad, as well as those of the low-grade division of the Allegheny Valley Railway, and those connected with the mines of the New York Central and Hudson River Railway. The number of establishments in the district increased from 8 in 1906 to 9 in 1907. All of these were operated during 1907, and the production increased from 770,095 short tons in 1906 to 870,831 short tons in 1907, with an increase in value from $1,794,127 in 1906 to $2,386,678 in 1907. The average price per ton advanced from $2.33 to $2.74.

The following are the statistics of the manufacture of coke in the Reynoldsville-Walston district for the years 1880, 1890, 1900, and from 1903 to 1907:

*Statistics of the manufacture of coke in the Reynoldsville-Walston district, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 3 | 117 | 0 | 45,055 | 28,090 | $46,359 | $1.65 | 62 |
| 1890 | 8 | 1,737 | 0 | 652,966 | 406,184 | 771,996 | 1.90 | 62 |
| 1900 | 7 | 2,010 | 0 | 1,115,923 | 625,553 | 1,347,869 | 2.15 | 56 |
| 1903 | 7 | 2,003 | 0 | 1,420,709 | 810,359 | 2,688,472 | 3.32 | 57.4 |
| 1904 | 8 | 2,101 | 200 | 1,313,507 | 709,502 | 1,585,950 | 2.24 | 54 |
| 1905 | 8 | 2,303 | 200 | 1,463,680 | 831,904 | 1,638,934 | 1.97 | 56.8 |
| 1906 | 8 | 2,502 | 0 | 1,399,801 | 770,095 | 1,794,127 | 2.33 | 55.8 |
| 1907 | 9 | 2,781 | 0 | 1,526,123 | 870,831 | 2,386,678 | 2.74 | 57.1 |

*Upper Connellsville district.*—This district includes that portion of the Connellsville trough or basin which lies north of a point a short distance south of the town of Latrobe, Westmoreland County. The coal of this district differs somewhat from that of the basin proper, so that in addition to its geographic position there is another reason for separating the production from that of the Connellsville district. The production in 1907 amounted to 1,030,260 short tons, valued at $2,457,072, against 1,011,229 short tons, valued at $2,172,748 in 1906, indicating a small increase in tonnage with a larger increase in value, the average price per ton having advanced from $2.15 in 1906 to $2.38 in 1907.

In the following table are given the statistics of the manufacture of coke in the Upper Connellsville district, Pennsylvania, in 1880, 1890, 1900, and from 1903 to 1907:

*Statistics of the manufacture of coke in the Upper Connellsville district, Pennsylvania, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 8 | 757 | 0 | 319,927 | 229,433 | $397,945 | $1.73 | 72 |
| 1890 | 14 | 1,569 | 28 | 889,277 | 577,246 | 1,008,102 | 1.75 | 64.9 |
| 1900 | 14 | 1,999 | 0 | 1,042,170 | 690,449 | 1,378,629 | 2.00 | 66.2 |
| 1903 | 19 | 2,556 | 280 | 1,180,947 | 784,132 | 2,133,513 | 2.72 | 66.4 |
| 1904 | 19 | 2,660 | 27 | 601,236 | 390,540 | 590,097 | 1.51 | 64.9 |
| 1905 | 19 | 2,434 | 30 | 1,159,158 | 755,946 | 1,445,568 | 1.91 | 65.2 |
| 1906 | 22 | 2,516 | 332 | 1,497,285 | 1,011,229 | 2,172,748 | 2.15 | 67.5 |
| 1907 | 22 | 2,724 | 223 | 1,557,978 | 1,030,260 | 2,457,072 | 2.38 | 66.1 |

## TENNESSEE.

The coke-making industry of Tennessee has remained nearly stationary in the last three years, the production in 1907 having amounted to 467,499 short tons, as compared with 483,428 tons in 1906, and 468,092 tons in 1905. The production of 1907 was within 5,507 tons of the average for the three years. In regard to the value of the product, however, there has been a decided increase, from $1,184,442 in 1905 to $1,350,856 in 1906 and to $1,592,225 in 1907. The average price per ton, which was as low as $2.39 in 1904, advanced to $2.53 in 1905, $2.79 in 1906, and $3.41 in 1907.

The total number of establishments in the State at the close of 1907 was 18, an increase of 1 over 1906. Of these 18 establishments 5, having a total of 769 ovens, were idle throughout the year. There was one establishment whose ovens were incomplete at the close of the year and did not contribute to the production during 1907. In 1906 there were 17 establishments, 3 of which, with a total of 536 ovens, were idle during the year. It appears from this that Tennessee did not participate in the general increased tonnage, though it did receive the benefit of the higher prices which prevailed during 1907. The 18 establishments in 1907 represented a total equipment of 2,806 ovens, compared with 2,731 in 1906. There were 80 ovens building at the close of the year.

The statistics of the manufacture of coke in Tennessee in the years 1880, 1890, 1900, and from 1903 to 1907 are shown in the following table:

*Statistics of the manufacture of coke in Tennessee, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 6 | 656 | 68 | 217,656 | 130,609 | $316,607 | $2.42 | 60 |
| 1890 | 11 | 1,664 | 292 | 600,387 | 348,728 | 684,116 | 1.96 | 58 |
| 1900 | 14 | 2,107 | 340 | 854,789 | 475,432 | 1,269,555 | 2.67 | 55.6 |
| 1903 | 16 | 2,439 | 304 | 1,001,356 | 546,875 | 1,706,722 | 3.12 | 54.6 |
| 1904 | 17 | 2,436 | 190 | 718,181 | 379,240 | 905,540 | 2.39 | 52.8 |
| 1905 | 16 | 2,615 | 60 | 862,320 | 468,092 | 1,184,442 | 2.53 | 54.3 |
| 1906 | 17 | 2,731 | 138 | 929,405 | 483,428 | 1,350,856 | 2.79 | 52 |
| 1907 | 18 | 2,806 | 80 | 825,221 | 467,499 | 1,592,225 | 3.41 | 56.6 |

The character of coal used in the manufacture of coke in Tennessee has been for several years about equally divided between run of mine and slack. In 1907 the coal used consisted of 770,824 tons of washed coal. In addition to this there were 54,397 tons of unwashed run of mine. All of the slack was washed.

The following table exhibits the character of the coal used in the manufacture of coke in Tennessee in 1890, 1895, 1900, and from 1903 to 1907:

*Character of coal used in the manufacture of coke in Tennessee, 1890–1907, in short tons.*

| Year. | Run of mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 255,359 | 0 | 273,028 | 72,000 | 600,387 |
| 1895 | 96,744 | 59,284 | 285,906 | 242,721 | 684,655 |
| 1900 | 150,697 | 349,448 | 24,122 | 330,522 | 854,789 |
| 1903 | 157,717 | 404,949 | 74,560 | 364,130 | 1,001,356 |
| 1904 | 1,471 | 302,943 | 60,784 | 352,983 | 718,181 |
| 1905 | 134,432 | 244,302 | 46,073 | 437,513 | 862,320 |
| 1906 | 81,825 | 509,532 | 142,843 | 195,205 | 929,405 |
| 1907 | 54,397 | 386,094 | 0 | 384,730 | 825,221 |

## UTAH.

As there is but one company in Utah engaged in the manufacture of coke the statistics of production have been included with those of the State of Colorado, which adjoins Utah on the east. The coals of Utah which are used in the manufacture of coke are practically identical in character with those of western Colorado.

## VIRGINIA.

All of the coking coals of Virginia are contained within a few counties in the extreme southwestern portion of the State, which are within the coal fields of the Appalachian province. There has been considerable activity shown in the development of properties in the last few years, particularly in Wise and Lee counties, and although the production for 1907 was slightly less than in 1906, there is strong probability of a marked increase within a few years, particularly following the development of the work which has been in progress in the Black Mountain region of Lee County, which has been going on for the last two or three years. The decrease in 1907 was due to the monetary troubles in the latter part of the year, this region feeling the effects of the financial stress almost immediately. As it was, the production decreased from 1,577,659 in 1906 to 1,545,288 short tons in 1907, a loss of 32,379 tons or 2.1 per cent. Owing, however, to the better prices which prevailed during the greater part of the year the value of the coke produced in 1907 shows an increase of $154,074, or from $3,611,659 in 1906 to $3,765,733 in 1907. There were 19 establishments in 1907, an increase of 1 over 1906, and the total number of ovens increased from 4,641 to 5,333 in 1907. One establishment of 400 ovens was idle throughout the year, and this was due to the fact that the mines at Keokee are still in process of development. The Newton-Chambers ovens at Pocahontas, 56 in number, continued idle during 1907. The greater part of the development which has resulted in actual production during the last few years has been carried on in Wise County on the Clinch Valley branch of the Norfolk and Western Railroad. The coke in this district is the only coke at the present time made in Virginia from coal mined exclusively within the State. There are two plants in Virginia, one at Lowmoor and one at Covington, the coal for both of which is drawn from the mines in the New River district of West Virginia. The coals for the ovens at Pocahontas and part of the Flat Top district of Tazewell County is obtained from mines whose workings extend across the State boundary line into West Virginia and a part of this coal production should be properly credited to West Virginia. The openings of the mines, however, and the coke ovens, are in Tazewell County, and it is customary to credit the coal, as well as the coke, to Virginia. The total production of Wise County in 1907 amounted to 1,353,225 short tons, or 87.6 per cent of the total for the State.

The statistics of the manufacture of coke in Virginia in 1883, when the first operations were begun, and in 1890, 1900, and from 1903 to 1907, inclusive, are shown in the following table:

*Statistics of the manufacture of coke in Virginia, 1883–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1883 | 1 | 200 | 0 | 39,000 | 25,340 | $44,345 | $1.75 | 65 |
| 1890 | 2 | 550 | 250 | 251,683 | 165,847 | 278,724 | 1.68 | 66 |
| 1900 | 7 | [a] 2,331 | 300 | 1,083,827 | 685,156 | 1,464,556 | 2.14 | 63.2 |
| 1903 | 16 | [a] 4,251 | 142 | 1,860,225 | 1,176,439 | 2,724,047 | 2.32 | 63.2 |
| 1904 | 16 | [a] 4,345 | 68 | 1,636,905 | 1,101,716 | 1,772,717 | 1.61 | 67.3 |
| 1905 | 16 | [a] 4,549 | 0 | 2,184,369 | 1,499,481 | 2,869,452 | 1.91 | 68.6 |
| 1906 | 18 | [a] 4,641 | 695 | 2,296,227 | 1,577,659 | 3,611,659 | 2.29 | 68.7 |
| 1907 | 19 | [a] 5,333 | 50 | 2,264,720 | 1,545,280 | 3,765,733 | 2.44 | 68.2 |

[a] Includes 56 Newton-Chambers by-product ovens.

All the coal used in the manufacture of coke in Virginia during 1907 was unwashed. Of the 2,264,720 tons used 1,271,518 tons were run-of-mine, and 993,202 tons were slack.

The following table shows the character of the coal used in coke making in Virginia in 1890, 1900, and from 1903 to 1907:

*Character of coal used in the manufacture of coke in Virginia, 1890–1907, in short tons.*

| Year. | Run-of-mine. |  | Slack. |  | Total. |
|---|---|---|---|---|---|
|  | Unwashed. | Washed. | Unwashed. | Washed. |  |
| 1890 | 98,215 | 0 | 153,468 | 0 | 251,683 |
| 1900 | 620,207 | 0 | 463,620 | 0 | 1,083,827 |
| 1903 | 857,332 | 0 | 1,002,893 | 0 | 1,860,225 |
| 1904 | 1,213,226 | 44,222 | 379,457 | 0 | 1,636,905 |
| 1905 | 1,096,656 | 0 | 1,087,713 | 0 | 2,184,369 |
| 1906 | 1,014,299 | 228,347 | 1,053,581 | 0 | 2,296,227 |
| 1907 | 1,271,518 | 0 | 993,202 | 0 | 2,264,720 |

## WASHINGTON.

Washington is the only one of the Pacific Coast States in which, so far as known, coking coals occur. The coking operations of Washington, when compared with those of some of the eastern States, are not of great importance, but they are of importance and of interest as establishing the fact that it is possible to make metallurgical coke from Pacific Coast coal. All the coking operations are in Pierce County in the central part of the State. There are five establishments in the State, four of which made coke in 1907. The only idle plant was a small, practically experimental establishment of 6 ovens. The other 4 establishments had a total equipment of 210 ovens, and the production in 1907 amounted to 52,028 short tons, valued at $293,019, against 45,642 short tons, valued at $226,977 in 1906. The average price per ton advanced from $4.99 in 1906 to $5.63 in 1907. All the coal used in coke making in Washington in 1907 was washed. Three of the plants used washed run-of-mine and one used washed slack.

The coke-making industry of Washington began in 1884, when 400 tons of coke were produced. The record since that time has been as follows:

*Statistics of the manufacture of coke in Washington, 1884–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1884 | 1 | 0 | 0 | 700 | 400 | $1,900 | $4.75 | 57.5 |
| 1890 | 2 | 30 | 80 | 9,120 | 5,837 | 46,696 | 8.00 | 64 |
| 1900 | 2 | 90 | 0 | 54,310 | 33,387 | 160,165 | 4.80 | 61.5 |
| 1903 | 6 | 256 | 0 | 73,119 | 45,623 | 214,776 | 4.71 | 62.4 |
| 1904 | 6 | 256 | 0 | 76,993 | 45,432 | 207,357 | 4.56 | 59 |
| 1905 | 5 | 216 | 0 | 85,715 | 53,137 | 251,717 | 4.74 | 62 |
| 1906 | 5 | 216 | 0 | 76,896 | 45,642 | 226,977 | 4.99 | 59.4 |
| 1907 | 5 | 216 | 0 | 85,860 | 52,028 | 293,019 | 5.63 | 60.6 |

## WEST VIRGINIA.

For a quarter of a century, during which the statistics of the coke production of the United States have been collected by the Geological Survey, and until the close of 1906 West Virginia and Alabama have been close rivals for second place among the coke-producing States and have frequently alternated with each other for the position. During 1907, however, there was a marked increase in the production of coke in West Virginia, while that of Alabama declined. As a result of this, the lead of over 800,000 which West Virginia maintained in 1905 and 1906 was increased to nearly 1,100,000 tons in 1907, and, as was stated in the report for 1906, the indications are that West Virginia will continue to rank next to Pennsylvania as a producer of coke. One of the factors which has added to the production of West Virginia has been the development of the Tug River district by the United States Coal and Coke Company, a subsidiary corporation of the United States Steel Corporation. The completion of the Coal and Coke Railway from Charleston to Elkins has opened up new coal areas in the central part of the State. It is anticipated that the Virginian Railway (formerly the Deepwater-Tidewater) will be completed during the year 1908, and this will give another outlet to tide water of the coal and coke of the southern part of the State. The completion of the Wabash interests (West Virginia Central and Pittsburg and Western Maryland railroads) will give outlet for the coals and cokes in the northern part of the State. In addition to these the older lines (Baltimore and Ohio, Norfolk and Western, and the Chesapeake and Ohio, have been building extensions to reach undeveloped coal areas, and all of this will tend to increase West Virginia's importance as a coal and coke producer. In the northwestern portion of the State immediate developments have followed the completion of the Morgantown and Kingwood Railroad, as is shown in the increased production in the Upper Monongahela district. It is perhaps unfortunate for the welfare of the State that the transportation facilities for carrying fuels out of the State are so excellent, as the railroads have been more interested in carrying coals and cokes to other markets than in building up manufacturing industries within the State's borders.

The coke production of West Virginia in 1907 amounted to 4,112,896 short tons, valued at $9,717,130, against 3,713,514 short tons, valued at $8,192,956, in 1906, an increase of 399,382 tons or 10.75 per cent in quantity, and of $1,524,174 or 18.60 per cent in value. There were 142 establishments in the State in 1907, an increase of 1 over 1906. The total number of completed ovens in the State showed a decrease from 19,714 in 1906 to 19,688 in 1907. There were a number of new establishments started in 1907, but these were all but one offset by the permanent abandonment of some plants which had been idle for several years. The dismantling of these plants is also responsible for the decrease in the number of ovens. Most of the abandoned plants were in the Upper Monongahela district. Of the 142 establishments in the State in 1907, 26, with a total of 1,437 ovens, were idle. These idle establishments included 1, with a total of 173 completed and 7 incomplete at the end of the year, which had not been put into operation. The active establishments were therefore 116, with a total of 18,251 ovens. Of the 26 idle establishments 17, with a total of 916 ovens (including 73 completed but not in operation), were in the Upper Monongahela district, and 8, with a total of 421 ovens, were in the New River district.

The following table exhibits the statistics of coke production in West Virginia in 1880, 1890, 1900, and from 1903 to 1907:

*Statistics of the manufacture of coke in West Virginia, 1880–1907.*

| Year. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| 1880 | 18 | 631 | 40 | 230,758 | 138,755 | $318,797 | $2.30 | 60 |
| 1890 | 55 | 4,060 | 334 | 1,395,266 | 833,377 | 1,524,746 | 1.83 | 60 |
| 1900 | 106 | [a]10,249 | 1,306 | 3,868,840 | 2,358,499 | 4,746,633 | 2.01 | 60.9 |
| 1903 | 136 | [a]15,613 | 2,687 | 4,347,160 | 2,707,818 | 7,115,842 | 2.63 | 62.3 |
| 1904 | 137 | [a]16,929 | 1,319 | 3,543,338 | 2,283,086 | 3,757,850 | 1.65 | 64.4 |
| 1905 | 143 | [a]19,189 | 1,214 | 5,329,695 | 3,400,593 | 6,548,205 | 1.92 | 63.8 |
| 1906 | 141 | [a]19,714 | 353 | 5,822,619 | 3,713,514 | 8,192,956 | 2.21 | 63.8 |
| 1907 | 142 | [a]19,688 | 459 | 6,536,795 | 4,112,896 | 9,717,130 | 2.36 | 62.9 |

[a] Includes 120 Semet-Solvay ovens at Wheeling.

As shown in the following table, by far the larger part (62.1 per cent) of the coal used for coke making in West Virginia is slack, nearly all of which is used without being washed.

The character of the coal used in the manufacture of coke in West Virginia in 1890, 1895, 1900, and from 1903 to 1907 is shown in the following table:

*Character of coal used in the manufacture of coke in West Virginia, 1890–1907, in short tons.*

| Year. | Run-of-mine. | | Slack. | | Total. |
|---|---|---|---|---|---|
| | Unwashed. | Washed. | Unwashed. | Washed. | |
| 1890 | 324,847 | 0 | 930,989 | 139,430 | 1,395,266 |
| 1895 | 405,725 | 24,054 | 1,476,003 | 182,034 | 2,087,816 |
| 1900 | 509,960 | 8,000 | 3,140,064 | 210,816 | 3,868,840 |
| 1903 | 1,149,761 | 3,000 | 2,890,310 | 304,089 | 4,347,160 |
| 1904 | 1,247,935 | 1,350 | 2,128,251 | 165,802 | 3,543,338 |
| 1905 | 1,445,099 | 1,950 | 3,577,793 | 304,853 | 5,329,695 |
| 1906 | 2,093,483 | 0 | 3,388,877 | 340,259 | 5,822,619 |
| 1907 | 2,451,811 | 27,067 | 3,874,817 | 183,100 | 6,536,795 |

### PRODUCTION BY DISTRICTS.

It has been customary in the preceding reports of this series to consider the coke production by the districts into which the State has been divided. These districts are known, respectively, as the Upper Monongahela, the Upper Potomac, the Kanawha, the New River, and the Flat Top. The first two are in the northern part of the State, and are named from the fact that they are drained by the headwaters of the Monongahela and Potomac rivers. The other three districts are in the southern portion of the State. The New River district includes the ovens along the line of the Chesapeake and Ohio Railroad and its branches from Quinnimont to Hawks Nest, near which point the coals of the New River series go below water level. The Kanawha district embraces all of the ovens along the Kanawha River and its tributaries from Mount Carbon to the western limit of the coal fields. The ovens of the Gauley Mountain Coal Company at Ansted are included in the New River district, although the Ansted coal belongs in reality to the Kanawha series and lies about 1,000 feet above the New River coals. The Flat Top region is also drained by the upper portion of the New River, and includes the ovens in West Virginia which belong to the Pocahontas coal field. The Flat Top district is by far the most important and bears the same relation to the production of West Virginia that the Connellsville district bears to that of Pennsylvania. Since 1900 the statistics of production of the Flat Top district have included the new operations along Tug River lying west of and continuous with the Flat Top district. The output from this district averages something over 50 per cent of the total coke product of the State. The production of coke in 1907 increased in every district except the Tygarts Valley and Upper Potomac, in which districts a decrease of about 20,000 tons was shown. The largest increase was in the Flat Top district, which includes the Tug River, and this increase was largely in the Tug River section of the district. The next important increase was in the Kanawha district, and this gain is due to the operations at Page on the Tidewater branch of the Virginian Railway.

The statistics of the production of West Virginia by districts in 1906 and 1907 are shown in the following tables:

*Production of coke in West Virginia in 1906 and 1907, by districts.*

1906.

| District. | Establishments. | Ovens. | | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
| | | Built. | Building. | | | | | |
| Flat Top[a] | 56 | 11,872 | 200 | 2,985,931 | 1,912,595 | $4,000,986 | $2.09 | 64.1 |
| Kanawha | 12 | 1,605 | 50 | 582,260 | 358,903 | 860,514 | 2.40 | 61.6 |
| New River | 25 | 2,039 | 0 | 394,365 | 240,474 | 658,729 | 2.74 | 60.9 |
| Upper Monongahela | 37 | [b] 2,873 | 50 | 1,028,258 | 659,427 | 1,412,215 | 2.14 | 64.1 |
| Upper Potomac and Tygarts Valley | 11 | 1,325 | 53 | 831,805 | 542,115 | 1,260,512 | 2.33 | 65.1 |
| Total | 141 | 19,714 | 353 | 5,822,619 | 3,713,514 | 8,192,956 | 2.21 | 63.8 |

[a] Includes Tug River district.

[b] Includes 120 Semet-Solvay ovens.

*Production of coke in West Virginia in 1906 and 1907, by districts*—Continued.

1907.

| District. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| Flat Top[a] | 55 | 11,613 | 50 | 3,436,902 | 2,193,064 | $4,893,772 | $2.23 | 63.8 |
| Kanawha | 12 | 1,660 | 202 | 739,724 | 451,043 | 1,168,888 | 2.59 | 61 |
| New River | 23 | 1,957 | 0 | 428,123 | 248,346 | 696,335 | 2.80 | 58 |
| Upper Monongahela | 40 | [b] 2,983 | 107 | 1,107,659 | 698,345 | 1,738,464 | 2.49 | 63 |
| Upper Potomac and Tygarts Valley | 12 | 1,475 | 100 | 824,387 | 522,098 | 1,219,671 | 2.34 | 63.3 |
| Total | 142 | 19,688 | 459 | 6,536,795 | 4,112,896 | 9,717,130 | 2.36 | 62.9 |

[a] Includes Tug River district.

[b] Includes 120 Semet-Solvay ovens.

*Flat Top district.*—Until the close of 1902 this district was, next to the Connellsville district of Pennsylvania, the most important coke-producing region of the United States, but the largely increased production of the Lower Connellsville, or Klondike, district of Pennsylvania in 1902 placed that district above the Flat Top as a coke producer. Like the coal of the Connellsville region, that of the Flat Top district of West Virginia produces a coke which makes an ideal blast-furnace fuel. Chemically, the Flat Top coke is superior to that of Connellsville, as it is lower in mineral content or ash, and it is regarded by some ironmasters as equal in physical properties to the Connellsville coke.

To the operations of the Flat Top district has been added that of the Tug River district, immediately to the west, in which the United States Coal and Coke Company has completed something over 2,000 ovens. The combined production of the Flat Top and Tug River districts in 1907 amounted to 2,193,064 short tons, valued at $4,893,772, an increase of 280,469 tons, or 14.7 per cent, in quantity and of $892,786, or 22.3 per cent, in value over the production of 1906. The Flat Top district really includes the coal mining and coke-making operations in Tazewell County, Va., and if this is added the total production for the district in 1907 amounted to 2,385,119 short tons.

The Flat Top district began producing in 1886. The output of the West Virginia portion of the district for 1890, and for that of the West Virginia Flat Top and Tug River districts in 1900 and from 1903 to 1907, has been as follows:

*Statistics of the manufacture of coke in the Flat Top district of West Virginia, 1886–1907.*

| Year. | Establishments | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1886 | 2 | 10 | 38 | 1,075 | 658 | $1,316 | $2.00 | 61.2 |
| 1890 | 17 | 1,584 | 252 | 566,118 | 325,576 | 571,239 | 1.75 | 57.5 |
| 1900[a] | 38 | 5,290 | 666 | 1,952,274 | 1,208,838 | 2,290,947 | 1.90 | 61.9 |
| 1903 | 51 | 8,994 | 1,329 | 2,094,127 | 1,314,758 | 3,126,512 | 2.38 | 62.8 |
| 1904 | 53 | 10,023 | 684 | 2,024,055 | 1,320,314 | 1,928,871 | 1.46 | 65.2 |
| 1905 | 56 | 11,287 | 1,074 | 3,162,820 | 2,042,123 | 3,604,923 | 1.77 | 64.6 |
| 1906 | 56 | 11,872 | 200 | 2,985,931 | 1,912,595 | 4,000,986 | 2.09 | 64.1 |
| 1907 | 55 | 11,613 | 50 | 3,436,902 | 2,193,064 | 4,893,772 | 2.23 | 63.8 |

[a] Includes establishments in the Tug River district since 1900.

*New River district.*—This district includes the ovens along the Chesapeake and Ohio Railroad and the New River from Quinnimont on the east to the junction of the New and Gauley rivers on the west. The ovens at Ansted on Gauley Mountain are included in this district, although the coal belongs by right to the Kanawha series. The coals of the New River district are for the most part high-grade coking coals, and the coke is a good blast-furnace fuel. It is also a high-grade steaming coal, nearly smokeless in character, and the demand for it as a steam coal is probably responsible for the somewhat backward tendency shown by the coke production during the last few years. Two establishments in the New River district were abandoned during 1907, reducing the number from 25 to 23, and the total number of ovens was reduced from 2,039 to 1,957. Of the 23 establishments in 1907, 8, with a total of 421 ovens, were idle, leaving 15 active establishments, with a total of 1,536 ovens, which produced in 1907 248,346 tons of coke valued at $696,335, against 240,474 tons, valued at $658,729 in 1906. The average price per ton advanced from $2.74 in 1906 to $2.80 in 1907.

The statistics of the manufacture of coke in the New River district in 1880, 1890, 1900, and from 1903 to 1907, have been as follows:

*Statistics of the manufacture of coke in the New River district, West Virginia, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 6 | 468 | 40 | 159,032 | 98,427 | $239,977 | $2.14 | 62 |
| 1890 | 12 | 773 | 4 | 275,458 | 174,295 | 377,847 | 2.17 | 63 |
| 1900 | 27 | 1,722 | 560 | 568,856 | 341,527 | 750,637 | 2.20 | 60 |
| 1903 | 28 | 2,243 | 500 | 619,230 | 368,844 | 1,129,701 | 3.06 | 59.5 |
| 1904 | 26 | 2,156 | 18 | 387,265 | 233,014 | 439,521 | 1.89 | 60.2 |
| 1905 | 25 | 2,129 | 0 | 514,850 | 301,626 | 622,815 | 2.06 | 58.6 |
| 1906 | 25 | 2,039 | 0 | 394,365 | 240,474 | 658,729 | 2.74 | 60.9 |
| 1907 | 23 | 1,957 | 0 | 428,123 | 248,346 | 696,335 | 2.80 | 58 |

*Kanawha district.*—The Kanawha district includes all of the ovens along the banks of the Kanawha River from its formation by the junction of the New and Gauley rivers to the western limits of the coal fields. It also includes the recent developments on the Virginian (Deepwater-Tidewater) Railroad along lower Loup Creek, and the inclusion of this latter factor is responsible for the marked increases in production in 1905, 1906, and 1907. The output of the district had decreased from 179,988 tons in 1903 to 92,014 tons in 1904. As a result of the bringing in of the Loup Creek production, the output in 1905 increased to 249,251 tons. This was further increased in 1906 to 358,903 tons, and again in 1907 to 451,043 tons. The increase in 1907 over 1906 was 92,140 tons, or 25.7 per cent. The value increased $308,374, or 35.8 per cent. There were 12 establishments in the district in 1907 and in 1906. Only one of these establishments in 1907 was idle, and this was one in which the ovens were entirely new and had not been completed before the close of the year.

The statistics of the manufacture of coke in the Kanawha district in 1880, 1890, 1900, and from 1903 to 1907, have been as follows:

*Statistics of the manufacture of coke in the Kanawha district, West Virginia, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 4 | 18 | 0 | 6,789 | 4,300 | $9,890 | $2.30 | 63.3 |
| 1890 | 6 | 474 | 0 | 182,340 | 104,076 | 196,583 | 1.89 | 57 |
| 1900 | 11 | 847 | 80 | 291,277 | 165,339 | 412,636 | 2.50 | 56.7 |
| 1903 | 13 | 967 | 321 | 296,552 | 179,988 | 567,308 | 3.15 | 60.7 |
| 1904 | 14 | 1,112 | 600 | 152,517 | 92,014 | 142,858 | 1.55 | 60.3 |
| 1905 | 14 | 1,617 | 0 | 415,808 | 249,251 | 504,734 | 2.03 | 60 |
| 1906 | 12 | 1,605 | 50 | 582,260 | 358,903 | 860,514 | 2.40 | 61.6 |
| 1907 | 12 | 1,660 | 202 | 739,724 | 451,043 | 1,168,888 | 2.59 | 61 |

*Upper Monongahela district.*—This district embraces coke ovens in the counties of Harrison, Marion, and Taylor, and derives its name from the fact that the region is drained by the headwaters of the Monongahela River. It includes the well-known mining regions in the vicinity of Clarksburg and Fairmont, which are among the most important in the State.

There were 40 establishments in the Upper Monongahela district, with a total of 2,983 completed ovens at the close of 1907. Of these 40 establishments 17, with a total of 916 ovens, were idle during the year. The idle ovens included 73 new ovens which had not been put in blast. The production increased from 659,427 tons, valued at $1,412,215, in 1906, to 698,345 tons, valued at $1,738,464, in 1907. The average price per ton advanced from $2.14 in 1906 to $2.49 in 1907.

The statistics of coke production in the Upper Monongahela district in 1880, 1890, 1900, and from 1903 to 1907, are shown in the following table:

*Statistics of the manufacture of coke in the Upper Monongahela district, West Virginia, 1880–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1880 | 8 | 145 | 0 | 64,937 | 36,028 | $68,930 | $1.91 | 55 |
| 1890 | 18 | 1,051 | 50 | 276,367 | 167,459 | 260,574 | 1.56 | 60 |
| 1900 | 24 | [a] 1,563 | 0 | 584,265 | 355,861 | 817,340 | 2.30 | 60.9 |
| 1903 | 37 | [a] 2,319 | 337 | 724,915 | 437,522 | 1,315,336 | 3.01 | 60.3 |
| 1904 | 37 | [a] 2,348 | 17 | 478,513 | 328,820 | 749,305 | 2.28 | 68.7 |
| 1905 | 39 | [a] 2,861 | 90 | 576,201 | 389,213 | 965,402 | 2.48 | 67.5 |
| 1906 | 37 | [a] 2,873 | 50 | 1,028,258 | 659,427 | 1,412,215 | 2.14 | 64.1 |
| 1907 | 49 | [a] 2,983 | 107 | 1,107,659 | 698,345 | 1,738,464 | 2.49 | 63 |

[a] Includes 120 Semet-Solvay ovens at Wheeling.

*Upper Potomac and Tygarts Valley district.*—The Upper Potomac district includes the ovens along the line of the West Virginia Central and Pittsburg Railroad, in the region drained by the upper waters of the Potomac River. The statistics since 1902 include also the operations of some new ovens in the Tygarts Valley just below the Ohio-

Potomac divide, but practically continuous with the Upper Potomac district. The number of establishments in this district increased from 11 in 1906 to 12 in 1907, and the number of completed ovens from 1,325 to 1,475, but the production decreased from 542,115 short tons in 1906 to 522,098 tons in 1907. The value decreased from $1,260,512 in 1906 to $1,219,671 in 1907. This is the only district in the State in which a decreased production was reported in 1907. One small establishment was abandoned during 1907 and one new plant was added. The ovens of the latter, however, were not completed before the end of the year. All of the other establishments were in operation during 1907.

The statistics of the manufacture of coke in the Upper Potomac and Tygarts Valley district in 1887, 1890, 1900, and from 1903 to 1907, are shown in the following table:

*Statistics of the manufacture of coke in the Upper Potomac and Tygarts Valley district, West Virginia, 1887–1907.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent) |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1887 | 1 | 20 | 50 | 3,565 | 2,211 | $4,422 | $2.00 | 62 |
| 1890 | 2 | 178 | 28 | 94,983 | 61,971 | 118,503 | 1.91 | 65 |
| 1900 | 6 | 827 | 0 | 472,168 | 286,934 | 475,073 | 1.66 | 60.8 |
| 1903 | 7 | 1,090 | 200 | 612,336 | 406,706 | 976,985 | 2.40 | 66.4 |
| 1904 | 7 | 1,290 | 0 | 500,988 | 308,924 | 497,295 | 1.61 | 61.7 |
| 1905 | 9 | 1,295 | 50 | 660,016 | 418,380 | 850,331 | 2.03 | 63.4 |
| 1906 | 11 | 1,325 | 53 | 831,805 | 542,115 | 1,260,512 | 2.33 | 65.1 |
| 1907 | 12 | 1,475 | 100 | 824,387 | 522,098 | 1,219,671 | 2.34 | 63.3 |

## OTHER STATES.

In the following table are presented the statistics of production of coke in the years 1900 to 1907 of those States in which there are but one or two establishments. These States are Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, and Wisconsin. Of the several States included in this statement, 6—Maryland, Michigan, Minnesota, New Jersey, New York, and Wisconsin—produced coke made from coal mined in other States, while 1—Massachusetts—obtained its chief supply of coal from Nova Scotia and smaller quantities from West Virginia. All of the ovens in Maryland, Massachusetts, Minnesota, New Jersey, New York, and Michigan are by-product retort ovens, and one of the two establishments in Wisconsin is also a by-product recovery plant. All of the ovens in Wyoming were abandoned in 1907, and this reduced the number of establishments in the following table from 12 to 11 and the total number of ovens from 1,952 to 1,878. The total combined production of the States included in the following table increased from 2,085,617 in 1906 to 2,528,739 tons in 1907, and the value increased from $7 474 889 in 1906 to $10,302,269 in 1907.

The statistics of production in the States having less than three establishments since 1900 are shown in the following table:

*Statistics of coke production from 1900 to 1907 in States having only one or two establishments.*

| Year. | Establishments. | Ovens. |  | Coal used (short tons). | Coke produced (short tons). | Total value of coke at ovens. | Value of coke at ovens, per ton. | Yield of coal in coke (per cent). |
|---|---|---|---|---|---|---|---|---|
|  |  | Built. | Building. |  |  |  |  |  |
| 1900 | 10 | 832 | 594 | 708,205 | 506,730 | $1,454,029 | $2.87 | 71.5 |
| 1901 | 11 | 862 | 609 | 793,187 | 564,191 | 1,607,476 | 2.849 | 71 |
| 1902 | 11 | 898 | 742 | 852,977 | 598,809 | 2,063,894 | 3.446 | 70.2 |
| 1903 | 17 | 1,308 | 760 | 1,306,707 | 932,428 | 3,228,064 | 3.46 | 71.3 |
| 1904 | 14 | 1,753 | 658 | 2,046,340 | 1,469,845 | 4,830,621 | 3.286 | 71.8 |
| 1905 | 12 | 1,666 | 145 | 2,222,723 | 1,660,857 | 5,500,337 | 3.31 | 74.7 |
| 1906 | 12 | 1,952 | 0 | 2,861,934 | 2,085,617 | 7,474,889 | 3.58 | 72.9 |
| 1907 | 11 | [a] 1,878 | 0 | 3,415,723 | 2,528,739 | 10,302,269 | 4.07 | 74 |

[a] Includes 350 Semet-Solvay, 1,018 United Otto, and 282 Rothberg ovens.

Of the total production of 2,528,739 short tons in 1907, shown in the preceding table, 2,429,795 short tons, or 96.09 per cent, were made in by-product retort ovens. This is a little less than half of the total production of by-product coke in 1907.

## RECENT LITERATURE REFERRING TO THE MANUFACTURE OF COKE.

As the subject of the manufacture of coke is not, strictly speaking, a subject of geological investigation, the Geological Survey reports on this subject are restricted chiefly to the volumes of Mineral Resources and to reports on the testing of the coking qualities of certain coals by the fuel-testing plant of the Geological Survey at St. Louis during the Exposition period, and since that time by the Technologic Branch of the Survey. The results of these tests are contained in the following Survey publications:

Bulletin 261. Preliminary report on the operations of the coal-testing plant at St. Louis during the Exposition period.

Professional Paper 48. Final report on the operations of the coal-testing plant at St. Louis during the Exposition period.

Bulletin 290. Preliminary report on the operations of the fuel-testing plant at St. Louis during 1905, subsequent to the Exposition period.

Bulletin 332. Report of the fuel-testing plant at St. Louis January 1, 1906, to June 30, 1907.

Bulletin 336. Washing and coking tests of coal and cupola tests of coke at the fuel-testing plant, St. Louis, Mo., January 1, 1905, to June 30, 1907.

Following is a list of contributions to literature on the subject which have appeared recently in the technical journals:

By-product coke as made in ovens of the Otto-Hoffmann and United-Otto system, with description of the plant at Camden, N. J., by Edwin A. Moore: Paper read before the Philadelphia Foundrymen's Association, February 1, 1905; published in Mines and Minerals July, 1905.

The manufacture of coke in Northern China: Illustrated description of methods employed at the Kaiping and other collieries; published in the Bi-Monthly Bulletin, American Institute of Mining Engineers, November, 1905.

By-product coke ovens: Paper read before the Engineers' Club of Philadelphia and published in the proceedings of the club for July, 1906, and in the Black Diamond, August 25, 1906.

By-product coke and the Huessener by-product coke oven: Paper read before the British Institution of Mining Engineers, published in the Iron and Coal Trades Review, London, June 15, 1906; abstracted in Mines and Minerals of Scranton, Pa., August, 1906.

The Koppers coke oven system: Paper by Herbst, in Glückauf, August 6, 1906—an illustrated article dealing with the general arrangement of the Koppers type of coke ovens; abstracted in Mines and Minerals for April, 1907.

Qualities of beehive and by-product cokes: Paper, by Robert Buchanan, read before the Cleveland Institution of Engineers, England, giving relative values of beehive and by-product cokes, London Mining World, March, 16, 1907.

Manufacture of coke from western coal: Paper by R. S. Moss in the Mining World, June 8, 1907—explains improvements claimed to have been made with the Hemingway coking process.

Coke drawing machines: Paper read before the Engineers Society of Western Pennsylvania, by Walter W. Macfarren, and published with illustrations in the Coal Trade Bulletin of April 15, 1908, the Industrial World of December 2, 1907, and the Iron Trade Review of December 26, 1907.

The Marmac coke drawing and loading machine: An illustrated description of this machine published in The Iron Age, December 26, 1907.

The Ernst coal charging machine: An illustrated description of machine for charging in Belgian ovens, published in The Iron Age, December 12, 1907.

Plant of modern Belgian type ovens: Illustrated description of plant under construction by the Connellsville Central Coke Company in the Connellsville district of Pennsylvania, by W. B. Robinson, published in The Iron Trade Review of Cleveland; abstracted in the Coal Trade Bulletin, December 2, 1907.

The Koppers coke oven: An illustrated description of the Koppers retort ovens under construction at Joliet, Ill.; published in The Iron Age, December 12, 1907,

By-product coke ovens at Joliet, Ill.: A brief description of the Koppers ovens under construction by the Illinois Steel Company at Joliet; published in The Iron Age, October 17, 1907.

Retort versus beehive coke ovens: Paper showing comparison of first costs and of economies in operation, by Alfred Ernst, Pittsburg; published in The Iron Age, January 6, 1908.

The Sheldon retort coke oven and process: An illustrated article describing the Sheldon retort oven, by S. B. Sheldon, Buffalo, N. Y.; published in The Iron Age, January 16, 1908.

The Von Bauer coke oven system: An illustrated description of the Von Bauer type of by-product coke oven; published in The Iron Age, February 27, 1908.

Present status of the by-product coke oven in the United States: Paper by C. G. Atwater, giving the quantity of coke and the various by-products produced in 1906; published in Mines and Minerals, February, 1908.

The Hebb coke drawing machine: An illustrated description of the Hebb coke drawing machine; published in The Iron Age, April 23, 1908.

Transition in coke making: An illustrated description of new forms of ovens and machines for quenching and drawing coke and leveling coke in ovens, by William L. Affelder; published in Mines and Minerals, May, 1908.

Making coke from Indiana coal: Description of the beehive coke oven plant near Linton, Greene County; published in the Engineering and Mining Journal, May 20, 1908.

# GAS, COKE, TAR, AND AMMONIA.

By Edward W. Parker.

## INTRODUCTION.

The statistics presented in this chapter have been compiled in response to a demand from producers of coke and gas, and while possibly not properly included in a report on mineral resources, which is supposed to be limited to the discussion of mineral production in the first marketable condition of the mineral products, the information is of interest in connection with and as supplemental to the reports on the production of coal and the manufacture of coke. The chapter on coke is restricted to the product obtained from the distillation or partial combustion of bituminous coal in beehive or by-product recovery ovens. It does not include the coke obtained as a by-product in the manufacture of illuminating gas, which is commonly known as "gas-house coke." The production of coke in by-product ovens is included in the chapter on coke, and it is also included in the quantity of coke reported in this chapter. The duplication is necessary to the completion of each report.

The first volume of Mineral Resources which contained a report on the production of gas, coke, tar, and ammonia at gas works and in retort ovens was that for 1898, a special report prepared by Dr. William B. Phillips. Reports which followed the general lines of the one prepared by Doctor Phillips were published in the volumes for 1902, 1903, 1904, and 1905. On account of pressure of other work no report on these subjects was published in the volume for 1906. The report for 1905 and the present chapter include, in addition to the statistics of the production of gas, coke, tar, and ammonia at gas works and in retort ovens, statements of the production of gas and tar at water-gas works. At some gas works oil is used for enriching purposes, and in a few cases oil gas is made. When the oil is used for enriching water or coal gas, the entire product is considered as water gas or coal gas.

In the preparation of the report for 1898 returns were received from 433 companies manufacturing gas from coal. This report did not include the production of gas, tar, and ammonia from the 520 by-product recovery coke ovens that were in operation that year. The statistics for 1902 and succeeding years included the production from both gas works and by-product oven plants, and those for 1905 and 1907, as already noted, contain statements of the production of gas and tar from water-gas works.

In 1902 there were 533 companies reporting, an increase of 100 from 1898, and the reports included returns from 1,663 by-product retort ovens. In 1903 reports were received from 528 coal-gas companies, and the statistics included the production from 1,956 by-product ovens. In 1904 the statistics included returns from 534 coal-gas companies and the production from 2,910 by-product ovens. In 1905 the coal-gas production was made up from returns received from 529 companies and 2,998 by-product ovens. The statistics for 1907 have been compiled from reports made by 516 companies and from 3,892 by-product ovens. The decrease in the number of producing companies is due partly to consolidations effected during the last two years and partly to the changing of some works from coal-gas to water-gas. It is probable also that the increased use of electricity for lighting purposes has caused the shutting down of gas works in comparatively small towns. Notwithstanding the decrease in the number of coal-gas companies reporting, the production of coal gas reported in 1907 (exclusive of that lost or unaccounted for) was 54,819,685,000 cubic feet, against 40,454,000,000 cubic feet in 1905, indicating an increase of gas sold in two years of 35 per cent.

The statistics of water-gas production show an increase in the number of companies from 477 in 1905 to 520 in 1907, and the production (exclusive of that lost or unaccounted for) increased from 77,412,000,000 cubic feet to 94,635,000,000 cubic feet, a gain of something over 22 per cent. The coal gas lost or unaccounted for in 1907 was 3,423,000,000 cubic feet, or about 6 per cent of the total production. The loss of water gas amounted to 7,505,000,000 cubic feet, or something over 7 per cent of the production.

Of the coal gas sold in 1907 approximately 30,000,000,000 cubic feet were for illuminating purposes and something like 24,000,000,000 cubic feet were for fuel purposes. Of the water gas sold approximately 72,000,000,000 cubic feet were used for lighting, and 22,500,000,000 cubic feet for fuel. It is impossible to secure exact information on this separation of the gas for illuminating or fuel purposes as in a great many cases the gas for the two purposes in household use is passed through the same meter, and no difference in price is made to the consumer. In selling gas for power purposes in large quantities, the case is different. The separation made in the statistics presented in this report is as correct as it is possible to make it.

## PRODUCTION.

As previously stated, the reports on the production of gas, coke, tar, and ammonia prior to 1905 did not include the operations of water-gas works, and for this reason the production of water gas in 1905 and 1907 will be considered separately. The following statistics include the operations of coal-gas works and by-product recovery coke ovens.

The total quantity of coal carbonized at coal-gas works and in by-product ovens in 1907 was 11,490,661 short tons, of which 7,460,587 short tons, or 65 per cent, were consumed in by-product oven plants, and 4,030,074 short tons, or 35 per cent, were used at gas works. The quantity of coal carbonized in 1907 exceeded that used in 1905 by 3,302,849 short tons, or about 40 per cent, the quantity of coal used in the latter year amounting to 8,187,812 short tons, of which 4,628,981 tons, or 57 per cent, were coked in retort ovens, and 3,558,831 tons, or 43 per cent, were carbonized in gas-house retorts.

In 1904 the quantity of coal used was almost equally divided between retort ovens and gas works; in 1903 the gas works used 55 per cent of the total and the retort ovens 45 per cent.

The total production in 1907 was 54,819,684,825 cubic feet of gas (not including that lost or wasted), 8,093,144 short tons of coke, 103,577,760 gallons of tar, 37,560,858 pounds of anhydrous ammonia (ammonia liquor production being reduced to its equivalent in $NH_3$), and 48,882,237 pounds of ammonium sulphate. The corresponding figures for 1905 were 40,454,215,132 cubic feet of gas, 5,751,378 short tons of coke, 80,022,043 gallons of tar, 22,455,857 pounds of anhydrous ammonia, and 38,663,682 pounds of ammonium sulphate. The total value of all these products in 1907 was $73,573,004, against $56,684,972 in 1905.

In the following table is presented a statement of the quantity of coal carbonized, and the quantity of gas, coke, and tar produced at gas works and in by-product ovens in 1905 and 1907. No separation by sources has been made of the ammonia produced. It should be distinctly understood that in giving the production of gas in by-product ovens only the "surplus" gas is considered, that is, the gas, over and above that used in the process, which is either sold or used for other purposes than heating the ovens. As a usual thing the gases which come off in the earlier stages of the process and which are richer in illuminants are the ones sold, while the leaner gases are used for heating the ovens. The quantity of gas sold at gas works per ton of coal carbonized in 1907 was 8,512 cubic feet, as against 2,750 cubic feet sold as surplus gas at retort ovens per ton of coal.

*Coal consumed and gas, coke, and tar produced at coal-gas works and in by-product coke ovens in the United States in 1905 and 1907.*

1905.

| Kind of product. | Gas works. | By-product coke plants. | Total. |
|---|---|---|---|
| Coal coked....short tons.. | 3,558,831 | 4,628,981 | 8,187,812 |
| Coal gas produced and sold....cubic feet.. | 30,722,278,832 | 9,731,936,300 | 40,454,215,132 |
| Coke produced....short tons.. | 2,289,030 | 3,462,348 | 5,751,378 |
| Tar produced....gallons.. | 43,642,189 | 36,379,854 | 80,022,043 |

1907.

| | | | |
|---|---|---|---|
| Coal coked....short tons.. | 4,030,074 | 7,460,587 | 11,490,661 |
| Coal gas produced and sold....cubic feet.. | 34,302,953,825 | 20,516,731,000 | 54,819,684,825 |
| Coke produced....short tons.. | 2,510,106 | 5,583,038 | 8,093,144 |
| Tar produced....gallons.. | 49,581,965 | 53,995,795 | 103,577,760 |

The total quantity and value of the gas, coke, tar, ammonia liquor (reduced to equivalent in $NH_3$), and of ammonium sulphate produced in 1903, 1904, 1905, and 1907 are shown in the following table. It will be observed that while the quantity of gas produced and sold in 1907 shows an increase of 35 per cent over 1905 the value of this product increased only 11 per cent. On the other hand, while the quantity of coke produced increased 41 per cent the value increased 61 per cent. Both of these opposite effects were due to the same cause, the larger proportionate production from by-product ovens. The coke from the by-product ovens is a much higher grade article than gas-house coke. It is used principally for blast-furnace and foundry purposes, for which gas-house coke is not adapted, and it commands, therefore, a better price. The average price per ton for all the coke from these sources in 1907 was $3.75, against $3.28 in 1905. The gas produced at by-product ovens, however, is sold at much lower rates than that from gas works, some of it as low as 9 or 10 cents per thousand cubic feet, and the larger proportion of this product is chiefly responsible for the apparent decrease in the price of gas in 1907, as compared with 1905, though another factor, the arbitrary reduction in prices by municipal authorities, had also some effect in this particular. The average price for all coal gas sold shows a decline from 81.4 cents in 1905 to 67 cents in 1907.

*Production of gas, coke, tar, and ammonia, and value thereof, at gas works and by-product coke ovens in the United States, 1903–1905, and 1907.*

| | 1903. | | 1904. | | 1905. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gas sold ........................ cubic feet.. | 31,049,461,511 | $30,315,776 | 34,814,991,273 | $32,090,998 | 40,454,215,132 | $32,937,456 | 54,819,684,825 | $36,462,304 |
| Coke ........................ short tons.. | 3,941,282 | 13,634,095 | 4,716,049 | 14,693,126 | 5,751,378 | 18,844,866 | 8,093,144 | 30,332,644 |
| Tar ........................ gallons.. | 62,964,393 | 2,199,969 | 69,498,085 | 2,114,421 | 80,022,043 | 2,176,944 | 103,577,760 | 2,651,527 |
| Ammonia (reduced to $NH_3$) ...... pounds.. | 17,643,507 | 1,291,732 | 19,750,032 | 1,487,196 | 22,455,857 | 1,728,254 | 37,560,858 | 2,601,057 |
| Ammonium sulphate ................ do.... | 12,400,032 | 389,028 | 28,225,210 | 771,996 | 38,663,682 | 997,452 | 48,882,237 | 1,525,472 |

## PRODUCTION OF COAL GAS.

The total quantity of gas produced at coal-gas works and by-product coke works in 1907, as reported by the 516 companies which made returns to the Geological Survey, was 58,242,544,402 cubic feet. Of this product 3,422,859,577 cubic feet were lost through leakage, fire, or otherwise and reported as unaccounted for. The net product sold, therefore, amounted to 54,819,684,825 cubic feet, which was valued at $36,462,304, or an average of 67 cents per thousand cubic feet. In 1905 the total quantity of gas sold was 40,454,215,132 cubic feet, valued at $32,937,456, an average of 81.4 cents per thousand cubic feet, so that while the quantity of gas sold increased 14,365,469,693 cubic feet, or 35 per cent, from 1905 to 1907, the value increased only $3,524,848, or 11 per cent, and the average price per thousand feet showed a decline of 14.4 cents. As already stated, this apparent decline in value was due principally to the largely increased production of by-product oven gas, most of which is used for fuel and all of which is sold at first hand at much lower rates than those obtained for gas produced as a primary product at gas works.

In the following table, showing the production of coal gas by States and Territories, a separation is made of the gas sold for illuminating and for fuel purposes. No claim for exactness in this separation is made, and the figures must be accepted as only approximately correct. In many cases, it is true, in order to encourage the use of gas for cooking purposes, the companies install additional meters and charge a lower price for such gas, although supplied from the same mains as the illuminating gas burned in the same houses. But in just as many cases, probably, particularly for household use, the gas for lighting and for cooking passes through the same meter, and the only estimates of the quantities used for the two purposes are roughly guessed at as such a percentage of the total. When gas is used in large quantities for power purposes, separate meters are generally used.

According to the best information obtainable the quantity of gas sold for illuminating purposes in 1907 was approximately 30,156,771,756 cubic feet, valued at $23,119,423, or 77 cents per thousand, while that sold for fuel purposes was 24,662,913,069 cubic feet, valued at $13,342,881, or 54 cents per thousand. In 1905 the quantity of gas sold for illuminating purposes was 26,817,836,022 cubic feet, valued at $23,138,361, or 86.3 cents per thousand cubic feet, and the gas sold for fuel purposes was 13,636,379,110 cubic feet, valued at $9,799,095, or 71.9 cents per thousand. The returns for 1907 show that Pennsylvania has superseded New York as a producer and consumer of coal gas. This has been largely due to the operations of the by-product coke ovens at Steelton and Lebanon. The production of coal gas reported from Pennsylvania in 1907 was nearly 9,500,000,000 cubic feet, about 75 per cent of which was sold for fuel purposes. New York produced nearly 8,300,000,000 cubic feet, of which nearly 5,000,000,000 cubic feet were sold for illuminating purposes, so that, while Pennsylvania's production exceeded New York's by more than 1,000,000,000 cubic feet, the value of the gas produced in New York exceeded that of Pennsylvania by $2,159,529, or 71 per cent. Massachusetts ranked third in the production of coal gas, with Ohio fourth, Michigan fifth, Illinois sixth, and Wisconsin seventh, all of these with the exception of Ohio having a larger production of coal gas on account of the operations of by-product ovens. In the production of water gas New York far outranks all the other States, with more than one-third of the total output.

In the quantity of coal carbonized Pennsylvania ranks first, with New York second, Massachusetts third, Illinois fourth, Michigan fifth, and Ohio sixth.

In the following table is presented a statement of the production of coal gas in 1905 and 1907, by States, with the quantity and value of that sold for illuminating and fuel purposes and the quantity lost or unaccounted for. It will be observed that as a usual thing prices are low in those States in which the artificial gas comes into competition with natural gas and also in those States where there is a large production from by-product coke ovens. The latter is particularly noticeable in Alabama, Maryland, Massachusetts, New Jersey, Pennsylvania, West Virginia, and Wisconsin.

*Quantity and value of gas produced and sold at by-product coke plants and coal-gas works of the United States in 1905, by States.*

| State. | Number of establishments. | Quantity of coal carbonized. | Total quantity gas produced. | Gas sold for illuminating purposes. | | | Gas sold for fuel purposes. | | | Total gas sold. | | | Quantity of gas unaccounted for. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | |
| | | *Short tons* | *Cubic feet.* | *Cubic fee* | | | *Cubic feet.* | | | *Cubic feet.* | | | *Cubic feet.* |
| Alabama | 11 | 543,404 | 1,958,779,780 | 88,178,060 | $112,931 | $1.28 | 1,817,320,120 | $316,886 | $0.17 | 1,905,498,180 | $429,817 | $0.22 | 53,281,600 |
| Arkansas | 4 | 6,228 | 53,414.400 | 32,893,940 | 47,006 | 1.43 | 19,020,460 | 25,020 | 1.31 | 51,914,400 | 72,026 | 1.39 | 1,500,000 |
| California | 3 | 3,192 | 30,634,128 | 11,463,121 | 24,016 | 2.09 | 19,010,912 | 23,777 | 1.25 | 30,474,033 | 47,793 | 1.56 | 160,095 |
| Colorado | 5 | 53,111 | 534,602,500 | 186,837,850 | 246,399 | 1.32 | 309,857,229 | 310,518 | 1.00 | 496,695,079 | 556,917 | 1.12 | 37,907,421 |
| Connecticut | 7 | 61,176 | 569,782,880 | 333,878,920 | 368,600 | 1.10 | 193,224,660 | 210,953 | 1.09 | 527,103,580 | 579,553 | 1.09 | 42,679,300 |
| Delaware | 3 | 7,790 | 69,557,200 | 38,280,500 | 38,504 | 1.00 | 22,409,500 | 22,722 | 1.00 | 60,690,000 | 61,226 | 1.00 | 8,867,200 |
| Florida, Louisiana, and Mississippi | 7 | 10,152 | 82,705,000 | 29,387,000 | 45,188 | 1.54 | 38,316,000 | 45,801 | 1.19 | 67,703,000 | 90,989 | 1.34 | 15,002,000 |
| Georgia | 9 | 54,209 | 480,648,600 | 243,059,500 | 266,673 | 1.09 | 225,513,350 | 224,465 | .99 | 468,572,850 | 491,138 | 1.04 | 12,075,750 |
| Idaho, North and South Dakota, Utah, and Wyoming | 8 | 15,403 | 135,539,636 | 40,528,052 | 70,648 | 1.74 | 67,676,760 | 96,057 | 1.42 | 108,204,812 | 166,705 | 1.54 | 27,334,824 |
| Illinois | 41 | 217,723 | 1,970,609,660 | 850,373,945 | 945,351 | 1.11 | 917,812,387 | 967,517 | 1.05 | 1,768,186,332 | 1,912,868 | 1.08 | 202,423,328 |
| Indiana | 33 | 149,521 | 1,333,705,443 | 704,757,008 | 680,893 | .96 | 511,415,966 | 489,054 | .95 | 1,216,172,974 | 1,169,947 | .96 | 117,532,469 |
| Indian Territory and Oklahoma | 5 | 6,610 | 52,194,000 | 13,834,000 | 16,163 | 1.16 | 38,360,000 | 39,629 | 1.03 | 52,194,000 | 55,792 | 1.07 | ............ |
| Iowa | 16 | 61,875 | 578,175,500 | 288,383,885 | 350,780 | 1.21 | 246,363,765 | 282,777 | 1.14 | 534,747,650 | 633,557 | 1.19 | 43,427,850 |
| Kansas | 7 | 19,150 | 172,128,000 | 46,598,400 | 73,582 | 1.58 | 105,249,000 | 120,728 | 1.14 | 151,847,400 | 194,310 | 1.28 | 20,280,600 |
| Kentucky | 12 | 81,285 | 690,614,347 | 335,862,264 | 364,032 | 1.08 | 260,466,256 | 175,692 | .67 | 596,328,520 | 539,724 | .90 | 94,285,827 |
| Maine | 7 | 17,128 | 176,418,780 | 106,969,415 | 151,363 | 1.41 | 47,099,060 | 60,894 | 1.29 | 154,068,475 | 212,257 | 1.37 | 22,350,305 |
| Maryland and District of Columbia | 8 | 540,647 | 1,798,698,675 | 1,713,957,825 | 551,735 | .32 | 39,812,184 | 44,623 | 1.12 | 1,753,770,009 | 596,358 | .34 | 44,928,666 |
| Massachusetts | 44 | 940,737 | 5,197,704,036 | 4,489,764,701 | 3,050,561 | .68 | 485,697,024 | 523,555 | 1.07 | 4,975,461,725 | 3,574.116 | .71 | 222,242,311 |
| Michigan | 42 | 626,166 | 3,440,593,395 | 2,153,938,046 | 1,373,993 | .63 | 1,109,665,013 | 951,384 | .85 | 3,263,603,059 | 2,325.377 | .71 | 176,990,336 |
| Minnesota | 8 | 190,729 | 882,820,400 | 567,219,410 | 542,951 | .96 | 267,471,800 | 299,648 | 1.12 | 834,691,210 | 842,599 | 1.01 | 48,129,190 |
| Missouri | 19 | 194,690 | 1,842,195,200 | 872,796,283 | 897,148 | 1.02 | 800,159,418 | 658,969 | .82 | 1,672,955,701 | 1,556,117 | .93 | 169,239,499 |
| Montana, Nevada, and New Mexico | 4 | 8,193 | 70,343,350 | 18,992,720 | 42,869 | 2.25 | 43,529,980 | 72,084 | 1.65 | 62,522,700 | 114,953 | 1.84 | 7,820,650 |
| Nebraska | 3 | 7,743 | 74.971,100 | 31,909,000 | 40,632 | 1.27 | 33,644,100 | 42,931 | 1.27 | 65,553,100 | 83,563 | 1.27 | 9,418,000 |
| New Hampshire and Vermont | 7 | 21,996 | 212.837,100 | 143,596,884 | 191,915 | 1.33 | 47,168,630 | 63,625 | 1.34 | 190,765,514 | 255,540 | 1.34 | 22,071,586 |
| New Jersey | 16 | 259,492 | 1,571,352,900 | 1,144,064,312 | 1,217,897 | 1.06 | 338,967,700 | 367,786 | 1.08 | 1,483,032,012 | 1,585,683 | 1.07 | 88,320 888 |
| New York | 51 | 689,726 | 5,481,602,963 | 4,417,698,676 | 4,442,425 | 1.00 | 586,968,718 | 647,632 | 1.10 | 5,004,667,394 | 5,090,057 | 1.01 | 476,935,569 |
| North Carolina | 6 | 10,198 | 73,758,900 | 35,969,300 | 58,374 | 1.62 | 22,878,930 | 27,637 | 1.20 | 58,848,230 | 86,011 | 1.46 | 14,910,670 |
| Ohio | 40 | 694,735 | 5,303,924,990 | 3,031,002,133 | 2,354,462 | .77 | 1,697,775,622 | 926,210 | .54 | 4,728,777,755 | 3,280,672 | .69 | 575,147,235 |
| Oregon | 3 | 2,268 | 18.716,200 | 10,580,300 | 25,025 | 2.36 | 7,550,900 | 14,650 | 1.94 | 18,131,200 | 39,675 | 2.18 | 585,000 |
| Pennsylvania | 30 | 1,883,037 | 4,054,510,624 | 2,190,416,022 | 2,094,618 | .96 | 1,720,253.283 | 173,887 | .10 | 3,910,669,305 | 2,268,505 | .58 | 143,841,319 |
| Rhode Island | 3 | 53,753 | 536,291,500 | 318,018,020 | 375,203 | 1.18 | 172,448,380 | 173,430 | 1.00 | 490,466,400 | 548,633 | 1.12 | 45,825,100 |
| South Carolina | 3 | 14,634 | 133.167,670 | 74,120,820 | 107,627 | 1.45 | 42,810,350 | 52,082 | 1.21 | 116,931,170 | 159.709 | 1.36 | 16,236,500 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tennessee.......... | 8 | 63,945 | 523,716,100 | 273,772,407 | 289,718 | 1.06 | 156,402,793 | 145,000 | .92 | 430,175,200 | 434,718 | 1.01 | 93,540,900 |
| Texas.............. | 10 | 19,188 | 177,287,790 | 60,402,007 | 105,997 | 1.75 | 106,515,665 | 147,569 | 1.38 | 166,917,672 | 253,566 | 1.52 | 10,370,118 |
| Virginia........... | 13 | 55,657 | 513,801,470 | 322,709,181 | 376,645 | 1.16 | 97,711,297 | 108,723 | 1.11 | 420,420,478 | 485,368 | 1.15 | 93,380,992 |
| Washington....... | 7 | 40,655 | 395,641,060 | 204,039,265 | 256,381 | 1.25 | 155,141,011 | 202,722 | 1.30 | 359,180,276 | 459,103 | 1.27 | 36,460,784 |
| West Virginia..... | 6 | 169,476 | 163,045,260 | 126,022,460 | 96,986 | .76 | 3,912,800 | 5,869 | 1.50 | 129,935,260 | 102,855 | .79 | 33,110,000 |
| Wisconsin.......... | 20 | 392,190 | 2,298,316,500 | 1,265,560,390 | 843,070 | .66 | 860,778,087 | 736,589 | .85 | 2,126,338,477 | 1,579,659 | .74 | 171,978,023 |
| Total........ | 529 | [a]8,187,812 | 43,654,807,037 | 26,817,836,022 | 23,138,361 | .863 | 13,636,379,110 | 9,799,095 | .719 | 40,454,215,132 | 32,937,456 | .814 | 3,200,501,905 |

[a] Includes 745,342 tons of coal carbonized in by-product coke ovens, none of the gas produced from it being sold.

*Quantity and value of gas produced and sold at by-product coke plants and coal-gas works of the United States in 1907, by States.*

| State. | Number of establishments. | Quantity of coal carbonized. | Total quantity gas produced. | Gas sold for illuminating purposes. | | | Gas sold for fuel purposes. | | | Total gas sold. | | | Quantity of gas unaccounted for. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | |
| | | *Short tons.* | *Cubic feet.* | *Cubic feet.* | | | *Cubic feet.* | | | *Cubic feet.* | | | *Cubic feet.* |
| Alabama | 11 | 709,754 | 1,963,605,670 | 90,400,661 | $96,342 | $1.07 | 1,831,570,891 | $398,786 | $0.22 | 1,921,971,552 | $495,128 | $0.26 | 41,634,118 |
| Arkansas | 4 | 6,986 | 53,016,680 | 22,191,507 | 32,385 | 1.46 | 25,413,803 | 30,705 | 1.21 | 47,605,310 | 63,090 | 1.33 | 5,411,370 |
| California | 1 | 1,725 | 15,998,242 | 8,271,181 | 17,585 | 2.13 | 7,142,114 | 14,589 | 2.04 | 15,413,295 | 32,174 | 2.09 | 584,947 |
| Oregon | 3 | | | | | | | | | | | | |
| Colorado | 7 | 74,192 | 738,555,700 | 232,258,988 | 239,714 | 1.03 | 412,582,758 | 397,020 | .96 | 644,841,746 | 636,734 | .99 | 93,713,954 |
| Connecticut | 7 | 73,317 | 679,103,992 | 399,795,191 | 411,780 | 1.03 | 238.758,737 | 248,107 | 1.04 | 638,553,928 | 659,887 | 1.03 | 40,550,064 |
| Delaware | 2 | 518,147 | 1,740,572,900 | 1,671,012,978 | 614,332 | .37 | 17,609,408 | 19,631 | 1.11 | 1,688,622,386 | 633,963 | .38 | 51,950,514 |
| District of Columbia | 2 | | | | | | | | | | | | |
| Maryland | 6 | | | | | | | | | | | | |
| Florida | 2 | 12,050 | 89,256,800 | 32,454,133 | 52,090 | 1.61 | 50,872,367 | 67,213 | 1.32 | 83,326,500 | 119,303 | 1.43 | 5,930,300 |
| Louisiana | 1 | | | | | | | | | | | | |
| Mississippi | 6 | | | | | | | | | | | | |
| Georgia | 8 | 67,083 | 600,438,907 | 241,573,199 | 274,931 | 1.14 | 326,948,792 | 337,326 | 1.03 | 568,521,991 | 612,257 | 1.08 | 31,916,916 |
| Idaho | 2 | 19,265 | 193,140,900 | 52,387,281 | 91.206 | 1.74 | 126,297,049 | 183,910 | 1.46 | 178,684,330 | 275,116 | 1.54 | 14,456,570 |
| Montana | 2 | | | | | | | | | | | | |
| North Dakota | 2 | | | | | | | | | | | | |
| South Dakota | 2 | | | | | | | | | | | | |
| Wyoming | 1 | | | | | | | | | | | | |
| Illinois | 44 | 767,280 | 3,732,355,671 | 2,284,589,764 | 1,237,641 | .54 | 1,228,261.506 | 1,270,209 | 1.03 | 3,512,851,270 | 2,507,850 | .71 | 219,504,401 |
| Indiana | 30 | 142,204 | 1,256,572,500 | 695,826,145 | 670,845 | .96 | 461,799,583 | 452,636 | ,98 | 1,157,625,728 | 1,123,481 | .97 | 98,946,772 |
| Iowa | 17 | 59,174 | 674,139,180 | 326,427,466 | 384,765 | 1.18 | 298,390,216 | 317,178 | 1.06 | 624,817,682 | 701,943 | 1.12 | 49,321,498 |
| Kansas | 3 | 14,493 | 138,016,796 | 55,229,624 | 71,346 | 1.29 | 65,744,683 | 87,410 | 1.33 | 120,974,307 | 158,756 | 1.31 | 17,042,489 |
| Nebraska | 3 | | | | | | | | | | | | |
| Kentucky | 13 | 99,679 | 900,931,523 | 321,301,027 | 339,142 | 1.06 | 479,906,145 | 358,819 | .75 | 801,207,172 | 697,961 | .87 | 99,724,351 |
| Maine | 7 | 20,290 | 205,095,250 | 141,671,058 | 190,782 | 1.35 | 43,945,465 | 54,759 | 1.25 | 185,616,523 | 245,541 | 1.32 | 19,478,727 |
| Massachusetts | 42 | 998,629 | 5,880,444,935 | 5,106,582,128 | 3,300,911 | .65 | 574,532,426 | 586,127 | 1.02 | 5,681,114,554 | 3,887,038 | .68 | 199,330,381 |
| Michigan | 48 | 742,885 | 4,421,706,914 | 2,468,897,537 | 1,609,722 | .65 | 1,674,804,902 | 1,452,066 | .87 | 4,143,702,439 | 3,061,788 | .74 | 278,004,475 |
| Minnesota | 9 | 205,519 | 1,215,976,051 | 637,931,009 | 462,695 | .73 | 527.181,864 | 403,344 | .76 | 1,165,112,873 | 866,039 | .74 | 50,863,178 |
| Missouri | 15 | 197,244 | 1,736,645,534 | 710,868,818 | 730,734 | 1.03 | 876,736,636 | 711,864 | .81 | 1,587,605,454 | 1,442,598 | .91 | 149,043,080 |
| Nevada | 1 | 11,792 | 116,394,900 | 26,523,755 | 49,834 | 1.88 | 63,399,189 | 66,221 | 1.04 | 89,922,944 | 116,055 | 1.29 | 26,471,956 |
| New Mexico | 1 | | | | | | | | | | | | |
| Utah | 2 | | | | | | | | | | | | |
| New Hampshire | 5 | 21,060 | 205,488,947 | 140,869,512 | 182,027 | 1.29 | 48,519,435 | 65,112 | 1.34 | 189,388,947 | 247,139 | 1.30 | 16,100,000 |
| Vermont | 2 | | | | | | | | | | | | |
| New Jersey | 16 | 422.883 | 2,168,050,700 | 1,061,594,579 | 783,051 | .74 | 1,070,985,805 | 610,776 | .57 | 2,132,580.384 | 1,393.827 | .65 | 35,470,316 |
| New York | 52 | 1,439,268 | 8,267,142,960 | 4,950,944,642 | 4,325,590 | .89 | 2,790,497,902 | 889,756 | .32 | 7,741,442,544 | 5,215,345 | .67 | 525,700,416 |
| North Carolina | 7 | 30,816 | 275,519,801 | 132,619,142 | 184,642 | 1.39 | 100,933,901 | 126,374 | 1.25 | 233,553,043 | 311,016 | 1.33 | 41,966,758 |
| South Carolina | 2 | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ohio........... | 32 | 720,705 | 5,232,129,432 | 2,795,735,719 | 2,250,356 | .80 | 1,724,839,427 | 1,015,887 | .59 | 4,520,575.146 | 3,266.243 | .72 | 711,554,286 |
| Oklahoma........ | 5 | 22,597 | 105,633,400 | 20,418,500 | 25,813 | 1.26 | 78,896,300 | 86,610 | 1 10 | 99,314,800 | 112,423 | 1.13 | 6,318,600 |
| Pennsylvania...... | 28 | 2,886,382 | 9.451,528,650 | 2,256,483,743 | 2,109,015 | .93 | 7,040,531,496 | 946,801 | .13 | 9,297,015,239 | 3,055,816 | .33 | 154,513,411 |
| Rhode Island...... | 3 | 56,821 | 554,995,200 | 306,737,159 | 292,715 | .95 | 223,625,336 | 214,630 | .96 | 530,362,495 | 507,345 | .96 | 24,632,705 |
| Tennessee......... | 7 | 66,703 | 588,245,663 | 342,602,474 | 341,101 | 1.00 | 151,176,989 | 154,287 | 1.02 | 493,779,463 | 495,388 | 1.00 | 94,466,200 |
| Texas............ | 7 | 28,292 | 251,233.400 | 53,281,311 | 88,688 | 1.66 | 167,885,909 | 224,104 | 1.33 | 221,167,220 | 312,792 | 1.41 | 30,066,180 |
| Virginia.......... | 13 | 66,075 | 621,241,609 | 372,354,993 | 405,149 | 1.09 | 147,639,903 | 173,935 | 1.18 | 519,994,896 | 579,084 | 1.11 | 101,246,773 |
| Washington....... | 9 | 58,172 | 548,867,500 | 233,455,171 | 300,138 | 1.29 | 281,912,531 | 374,856 | 1.33 | 515.367,702 | 674,994 | 1.31 | 33,499,798 |
| West Virginia...... | 3 | 223,287 | 569,795,500 | 109,764,500 | 82,478 | .75 | 460,031.000 | 61,388 | .13 | 569,795,500 | 143,866 | .25 | ............ |
| Wisconsin......... | 21 | 705,902 | 3,050.609,535 | 1,853,716,861 | 869,878 | .47 | 1,043,538,601 | 940,446 | .91 | 2,897,255,462 | 1,810,324 | .62 | 153,444,073 |
| Total........ | 516 | 11,490,661 | 58,242,544,402 | 30,156,771,756 | 23,119,423 | .77 | 24,662,913,069 | 12,342,881 | .54 | 54,819,684,825 | 36 462.304 | .67 | 3.422,859.577 |

In the production and transportation of gas there is necessarily a considerable loss entailed through leakage and fire or other accident, and of the total production of 58,242,544,402 cubic feet in 1907, 3,422,859,577 cubic feet were reported as lost or unaccounted for. This loss was equivalent to 5.9 per cent of the total production. In this respect there was an improvement over 1905, in which year, out of a total of 43,654,807,037 cubic feet, 3,200,591,905, or 7.3 per cent, was lost. The largest relative losses in 1907 were shown in the production of Virginia, Tennessee, North Carolina and South Carolina, Ohio, Colorado, and the combined production of Nevada, New Mexico, and Utah. The smallest losses were reported in Pennsylvania, New Jersey, Alabama, in the combined production of Maryland, Delaware, and the District of Columbia, and in Massachusetts, and California and Oregon. In the following table is shown the total quantity of gas produced in each State and Territory arranged according to rank, in 1905 and 1907, with the quantity and percentage of the gas sold and lost or unaccounted for. Part of the gas unaccounted for is used by the company producing it and is not really a loss.

*Rank of States in coal-gas production and the quantity sold and unaccounted for in 1905 and 1907, by States.*

1905.

| Rank. | State. | Total production. | Gas sold. | | Gas unaccounted for. | |
|---|---|---|---|---|---|---|
| | | | Quantity. | Percentage. | Quantity. | Percentage. |
| | | *Cubic feet.* | *Cubic feet.* | | *Cubic feet.* | |
| 1 | New York | 5,481,602,963 | 5,004,667,394 | 91.3 | 476,935,569 | 8.7 |
| 2 | Ohio | 5,303,924,990 | 4,728,777,755 | 89.2 | 575,147,235 | 10.8 |
| 3 | Massachusetts | 5,197,704,036 | 4,975,461,725 | 95.7 | 222,242,311 | 4.3 |
| 4 | Pennsylvania | 4,054,510,624 | 3,910,669,305 | 96.5 | 143,841,319 | 3.5 |
| 5 | Michigan | 3,440,593,395 | 3,263,603,059 | 94.9 | 176,990,336 | 5.1 |
| 6 | Wisconsin | 2,298,316,500 | 2,126,338,477 | 92.5 | 171,978,023 | 7.5 |
| 7 | Illinois | 1,970,609,660 | 1,768,186,332 | 89.7 | 202,423,328 | 10.3 |
| 8 | Alabama | 1,958,779,780 | 1,905,498,180 | 97.3 | 53,281,600 | 2.7 |
| 9 | Missouri | 1,842,195,200 | 1,672,955,701 | 90.8 | 169,239,499 | 9.2 |
| 10 | District of Columbia and Maryland | 1,798,698,675 | 1,753,770,009 | 97.5 | 44,928,666 | 2.5 |
| 11 | New Jersey | 1,571,352,900 | 1,483,032,012 | 94.4 | 88,320,888 | 5.6 |
| 12 | Indiana | 1,333,705,443 | 1,216,172,974 | 91.2 | 117,532,469 | 8.8 |
| 13 | Minnesota | 882,820,400 | 834,691,210 | 94.5 | 48,129,190 | 5.5 |
| 14 | Kentucky | 690,614,347 | 596,328,520 | 86.4 | 94,285,827 | 13.6 |
| 15 | Iowa | 578,175,500 | 534,747,650 | 92.5 | 43,427,850 | 7.5 |
| 16 | Connecticut | 569,782,880 | 527,103,580 | 92.5 | 42,679,300 | 7.5 |
| 17 | Rhode Island | 536,291,500 | 490,466,400 | 91.5 | 45,825,100 | 8.5 |
| 18 | Colorado | 534,602,500 | 496,695,079 | 92.9 | 37,907,421 | 7.1 |
| 19 | Tennessee | 523,716,100 | 430,175,200 | 82.1 | 93,540,900 | 17.9 |
| 20 | Virginia | 513,801,470 | 420,420,478 | 81.8 | 93,380,992 | 18.2 |
| 21 | Georgia | 480,648,600 | 468,572,850 | 97.5 | 12,075,750 | 2.5 |
| 22 | Washington | 395,641,060 | 359,180,276 | 90.8 | 36,460,784 | 9.2 |
| 23 | New Hampshire and Vermont | 212,837,100 | 190,765,514 | 89.6 | 22,071,586 | 10.4 |
| 24 | Texas | 177,287,790 | 166,917,672 | 94.2 | 10,370,118 | 5.8 |
| 25 | Maine | 176,418,780 | 154,068,475 | 87.4 | 22,350,305 | 12.6 |
| 26 | Kansas | 172,128,000 | 151,847,400 | 88.2 | 20,280,600 | 11.8 |
| 27 | West Virginia | 163,045,260 | 129,935,260 | 79.7 | 33,110,000 | 20.3 |
| 28 | Idaho, North and South Dakota, Utah, and Wyoming | 135,539,636 | 108,204,812 | 79.8 | 27,334,824 | 20.2 |
| 29 | South Carolina | 133,167,670 | 116,931,170 | 87.8 | 16,236,500 | 12.2 |
| 30 | Florida, Louisiana, and Mississippi | 82,705,000 | 67,703,000 | 81.9 | 15,002,000 | 18.1 |
| 31 | Nebraska | 74,971,100 | 65,553,100 | 87.4 | 9,418,000 | 12.6 |
| 32 | North Carolina | 73,758,900 | 58,848,230 | 79.8 | 14,910,670 | 20.2 |
| 33 | Montana, Nevada, and New Mexico | 70,343,350 | 62,522,700 | 88.9 | 7,820,650 | 11.1 |
| 34 | Delaware | 69,557,200 | 60,690,000 | 87.3 | 8,867,200 | 12.7 |
| 35 | Arkansas | 53,414,400 | 51,914,400 | 97.2 | 1,500,000 | 2.8 |
| 36 | Indian Territory and Oklahoma | 52,194,000 | 52,194,000 | 100.0 | ............ | ........ |
| 37 | California | 30,634,128 | 30,474,033 | 99.5 | 160,095 | .5 |
| 38 | Oregon | 18,716,200 | 18,131,200 | 96.9 | 585,000 | 3.1 |
| | Total | 43,654,807,037 | 40,454,215,132 | 92.7 | 3,200,591,905 | 7.3 |

*Rank of States in coal-gas production and the quantity sold and unaccounted for in 1905 and 1907, by States*—Continued.

### 1907.

| Rank. | State. | Total production. | Gas sold. |  | Gas unaccounted for |  |
|---|---|---|---|---|---|---|
|  |  |  | Quantity. | Percentage | Quantity. | Percentage. |
|  |  | *Cubic feet.* | *Cubic feet.* |  | *Cubic feet.* |  |
| 1 | Pennsylvania | 9,451,528,650 | 9,297,015,239 | 98.4 | 154,513,411 | 1.6 |
| 2 | New York | 8,267,142,960 | 7,741,442,544 | 93.6 | 525,700,416 | 6.4 |
| 3 | Massachusetts | 5,880,444,935 | 5,681,114,554 | 96.6 | 199,330,381 | 3.4 |
| 4 | Ohio | 5,232,129,432 | 4,520,575,146 | 86.4 | 711,554,286 | 13.6 |
| 5 | Michigan | 4,421,706,914 | 4,143,702,439 | 93.7 | 278,004,475 | 6.3 |
| 6 | Illinois | 3,732,355,671 | 3,512,851,270 | 94.1 | 219,504,401 | 5.9 |
| 7 | Wisconsin | 3,050,699,535 | 2,897,255,462 | 95.0 | 153,444,073 | 5.0 |
| 8 | New Jersey | 2,168,050,700 | 2,132,580,384 | 98.4 | 35,470,316 | 1.6 |
| 9 | Alabama | 1,963,605,670 | 1,921,971,552 | 97.9 | 41,634,118 | 2.1 |
| 10 | Delaware, District of Columbia, and Maryland | 1,740,572,900 | 1,688,622,386 | 97.0 | 51,950,514 | 3.0 |
| 11 | Missouri | 1,736,648,534 | 1,587,605,454 | 91.4 | 149,043,080 | 8.6 |
| 12 | Indiana | 1,256,572,500 | 1,157,625,728 | 92.1 | 98,946,772 | 7.9 |
| 13 | Minnesota | 1,215,976,051 | 1,165,112,873 | 95.8 | 50,863,178 | 4.2 |
| 14 | Kentucky | 900,931,523 | 801,207,172 | 88.9 | 99,724,351 | 11.1 |
| 15 | Colorado | 738,555,700 | 644,841,746 | 87.3 | 93,713,954 | 12.7 |
| 16 | Connecticut | 679,103,992 | 638,553,928 | 94.0 | 40,550,064 | 6.0 |
| 17 | Iowa | 674,139,180 | 624,817,682 | 92.7 | 49,321,498 | 7.3 |
| 18 | Virginia | 621,241,669 | 519,994,896 | 83.7 | 101,246,773 | 16.3 |
| 19 | Georgia | 600,438,907 | 568,521,991 | 94.7 | 31,916,916 | 5.3 |
| 20 | Tennessee | 588,245,663 | 493,779,463 | 83.9 | 94,466,200 | 16.1 |
| 21 | West Virginia | 569,795,500 | 509,795,500 | 100.0 | ........ | .... |
| 22 | Rhode Island | 554,995,200 | 530,362,495 | 95.6 | 24,632,705 | 4.4 |
| 23 | Washington | 548,867,500 | 515,367,702 | 93.9 | 33,499,798 | 6.1 |
| 24 | North Carolina and South Carolina | 275,519,801 | 233,553,043 | 84.8 | 41,966,758 | 15.2 |
| 25 | Texas | 251,233,400 | 221,167,220 | 88.0 | 30,066,180 | 12.0 |
| 26 | New Hampshire and Vermont | 205,488,947 | 189,388,947 | 92.2 | 16,100,000 | 7.8 |
| 27 | Maine | 205,095,250 | 185,616,523 | 90.5 | 19,478,727 | 9.5 |
| 28 | Idaho, Montana, North Dakota, South Dakota, and Wyoming | 193,140,900 | 178,684,330 | 92.5 | 14,456,570 | 7.5 |
| 29 | Kansas and Nebraska | 138,016,796 | 120,974,307 | 87.7 | 17,042,489 | 12.3 |
| 30 | Nevada, New Mexico, and Utah | 116,394,900 | 89,922,944 | 77.3 | 26,471,956 | 22.7 |
| 31 | Oklahoma | 105,633,400 | 99,314,800 | 94.0 | 6,318,600 | 6.0 |
| 32 | Florida, Louisiana, and Mississippi | 89,256,800 | 83,326,500 | 93.3 | 5,930,300 | 6.7 |
| 33 | Arkansas | 53,016,680 | 47,605,310 | 89.8 | 5,411,370 | 10.2 |
| 34 | California and Oregon | 15,998,242 | 15,413,295 | 96.3 | 584,947 | 3.7 |
|  | Total | 58,242,544,402 | 54,819,684,825 | 94.1 | 3,422,859,577 | 5.9 |

Owing partly to the increased production of gas from by-product coke ovens and partly to the growing popularity of gas for cooking and for other household heating purposes, a marked increase is shown in the proportion of gas used for fuel and a corresponding decrease in the proportion of gas used for illuminating purposes. In 1902 the gas used for illuminating purposes amounted to 80.45 per cent of the total; in 1903 the proportion had fallen off to 75 per cent; in 1904 it was 74 per cent; in 1905 it was 66 per cent, and in 1907 it had fallen to 55 per cent. The proportion of gas used for heating purposes, on the other hand, has increased from 19.55 per cent in 1902 to 45 per cent in 1907. This is to be accounted for by the fact that many of the gas-making companies offer inducements in the way of lower prices for gas when used for cooking and heating purposes even when drawn from the same mains as the illuminating gas, separate meters being installed—and the cleanliness and convenience of gas are not to be questioned. It must also be remembered that a large part of the gas produced at the by-product ovens is used for iron and steel making, the ovens being operated in connection with the iron and steel mills. The actual quantity of gas consumed for fuel purposes has increased nearly 350 per cent, from 5,678,000,000 cubic feet in 1902 to 24,663,000,000 in 1907.

The following table shows the total quantity of gas consumed in 1905 and 1907, by States, with the quantity and percentage used for illuminating and fuel purposes:

*Quantity of illuminating and fuel coal gas sold in 1905 and 1907, by States.*

1905.

| State. | Total sales. | Illuminating. | | Fuel. | |
|---|---|---|---|---|---|
| | | Quantity. | Percentage. | Quantity. | Percentage. |
| | *Cubic feet.* | *Cubic feet.* | | *Cubic feet.* | |
| Alabama | 1,905,498,180 | 88,178,060 | 5 | 1,817,320,120 | 95 |
| Arkansas | 51,914,400 | 32,893,940 | 63 | 19,020,460 | 37 |
| California | 30,474,033 | 11,463,121 | 38 | 19,010,912 | 62 |
| Colorado | 496,695,079 | 186,837,850 | 38 | 309,857,229 | 62 |
| Connecticut | 527,103,580 | 333,878,920 | 63 | 193,224,660 | 37 |
| Delaware | 60,690,000 | 38,280,500 | 63 | 22,409,500 | 37 |
| Florida, Louisiana, and Mississippi | 67,703,000 | 29,387,000 | 43 | 38,316,000 | 57 |
| Georgia | 468,572,850 | 243,059,500 | 52 | 225,513,350 | 48 |
| Idaho, North and South Dakota, Utah, and Wyoming | 108,204,812 | 40,528,052 | 37 | 67,676,760 | 63 |
| Illinois | 1,768,186,332 | 850,373,945 | 48 | 917,812,387 | 52 |
| Indiana | 1,216,172,974 | 704,757,008 | 58 | 511,415,966 | 42 |
| Indian Territory and Oklahoma | 52,194,000 | 13,834,000 | 26 | 38,360,000 | 74 |
| Iowa | 534,747,650 | 288,383,885 | 54 | 246,363,765 | 46 |
| Kansas | 151,847,400 | 46,598,400 | 31 | 105,249,000 | 69 |
| Kentucky | 596,328,520 | 335,862,264 | 56 | 260,466,256 | 44 |
| Maine | 154,068,475 | 106,969,415 | 69 | 47,099,060 | 31 |
| Maryland and District of Columbia | 1,753,770,009 | 1,713,957,825 | 98 | 39,812,184 | 2 |
| Massachusetts | 4,975,461,725 | 4,489,764,701 | 90 | 485,697,024 | 10 |
| Michigan | 3,263,603,059 | 2,153,938,046 | 66 | 1,109,665,013 | 34 |
| Minnesota | 834,691,210 | 567,219,410 | 68 | 267,471,800 | 32 |
| Missouri | 1,672,955,701 | 872,796,283 | 52 | 800,159,418 | 48 |
| Montana, Nevada, and New Mexico | 62,522,700 | 18,992,720 | 30 | 43,529,980 | 70 |
| Nebraska | 65,553,100 | 31,909,000 | 49 | 33,644,100 | 51 |
| New Hampshire and Vermont | 190,765,514 | 143,596,884 | 75 | 47,168,630 | 25 |
| New Jersey | 1,483,032,012 | 1,144,064,312 | 77 | 338,967,700 | 23 |
| New York | 5,004,667,394 | 4,417,698,676 | 88 | 586,968,718 | 12 |
| North Carolina | 58,848,230 | 35,969,300 | 61 | 22,878,930 | 39 |
| Ohio | 4,728,777,755 | 3,031,002,133 | 64 | 1,697,775,622 | 36 |
| Oregon | 18,131,200 | 10.580,300 | 58 | 7,550,900 | 42 |
| Pennsylvania | 3,910,669,305 | 2,190,416,022 | 56 | 1,720,253,283 | 44 |
| Rhode Island | 490,466,400 | 318,018,020 | 65 | 172,448,380 | 35 |
| South Carolina | 116,931,170 | 74,120.820 | 63 | 42.810,350 | 37 |
| Tennessee | 430,175.200 | 273,772,407 | 64 | 156,402,793 | 36 |
| Texas | 166,917.672 | 60,402.007 | 36 | 106,515,665 | 64 |
| Virginia | 420,420.478 | 322,709,181 | 77 | 97,711,297 | 23 |
| Washington | 359,180.276 | 204,039,265 | 57 | 155,141,011 | 43 |
| West Virginia | 129,935.260 | 126.022,460 | 97 | 3,912,800 | 3 |
| Wisconsin | 2,126,338,477 | 1,265,560,390 | 60 | 860,778,087 | 40 |
| Total | 40,454,215,132 | 26,817,836,022 | 66 | 13,636,379,110 | 34 |

1907.

| | | | | | |
|---|---|---|---|---|---|
| Alabama | 1,921,971,552 | 90,400,661 | 4.7 | 1,831,570,891 | 95.3 |
| Arkansas | 47,605,310 | 22,191,507 | 46.6 | 25,413,803 | 53.4 |
| California and Oregon | 15,413,295 | 8,271,181 | 53.7 | 7,142,114 | 46.3 |
| Colorado | 644,841,746 | 232,258,988 | 36.0 | 412,582,758 | 64.0 |
| Connecticut | 638,553,928 | 399,795,191 | 62.6 | 238,758,737 | 37.4 |
| Delaware, District of Columbia, and Maryland | 1,688,622,386 | 1,671,012,978 | 99.0 | 17,609,408 | 1.0 |
| Florida, Louisiana, and Mississippi | 83,326,500 | 32,454,133 | 38.9 | 50,872,367 | 61.1 |
| Georgia | 568,521,991 | 241,573,199 | 42.5 | 326,948,792 | 57.5 |
| Idaho, Montana, North and South Dakota, and Wyoming | 178,684,330 | 52,387,281 | 29.3 | 126,297,049 | 70.7 |
| Illinois | 3,512,851,270 | 2,284,589,764 | 65.0 | 1,228,261,506 | 35.0 |
| Indiana | 1,157,625,728 | 695,826,145 | 60.1 | 461,799,583 | 39.9 |
| Iowa | 624,817,682 | 326,427,466 | 52.2 | 298,390,216 | 47.8 |
| Kansas and Nebraska | 120,974,307 | 55,229,624 | 45.7 | 65,744,683 | 54.3 |
| Kentucky | 801,207,172 | 321,301,027 | 40.1 | 479,906,145 | 59.9 |
| Maine | 185,616,523 | 141,671,058 | 76.3 | 43,945,465 | 23.7 |
| Massachusetts | 5,681,114,554 | 5,106,582,128 | 89.9 | 574,532,426 | 10.1 |
| Michigan | 4,143,702,439 | 2,468,897,537 | 59.6 | 1,674,804,902 | 40.4 |
| Minnesota | 1,165,112,873 | 637,931,009 | 54.8 | 527,181,864 | 45.2 |
| Missouri | 1,587,605,454 | 710,868,818 | 44.8 | 876,736,636 | 55.2 |
| Nevada, New Mexico, and Utah | 89,922,944 | 26,523,755 | 29.5 | 63,399,189 | 70.5 |
| New Hampshire and Vermont | 189,388,947 | 140,869,512 | 74.4 | 48,519,435 | 25.6 |

*Quantity of illuminating and fuel coal gas sold in 1905 and 1907, by States*—Continued.

1907—Continued.

| State. | Total sales. | Illuminating. |  | Fuel. |  |
|---|---|---|---|---|---|
|  |  | Quantity. | Percentage. | Quantity. | Percentage. |
|  | *Cubic feet.* | *Cubic feet.* |  | *Cubic feet.* |  |
| New Jersey | 2,132,580,384 | 1,061,594,579 | 49.8 | 1,070,985,805 | 50.2 |
| New York | 7,741,442,544 | 4,950,944,642 | 64.0 | 2,790,497,902 | 36.0 |
| North and South Carolina | 233,553,043 | 132,619,142 | 56.8 | 100,933,901 | 43.2 |
| Ohio | 4,520,575,146 | 2,795,735,719 | 61.8 | 1,724,839,427 | 38.2 |
| Oklahoma | 99,314,800 | 20,418,500 | 20.6 | 78,896,300 | 79.4 |
| Pennsylvania | 9,297,015,239 | 2,256,483,743 | 24.3 | 7,040,531,496 | 75.7 |
| Rhode Island | 530,362,495 | 306,737,159 | 57.8 | 223,625,336 | 42.2 |
| Tennessee | 493,779,463 | 342,602,474 | 69.4 | 151,176,989 | 30.6 |
| Texas | 221,167,220 | 53,281,311 | 24.1 | 167,885,909 | 75.9 |
| Virginia | 519,994,896 | 372,354,993 | 71.6 | 147,639,903 | 28.4 |
| Washington | 515,367,702 | 233,455,171 | 45.3 | 281,912,531 | 54.7 |
| West Virginia | 569,795,500 | 109,764,500 | 19.3 | 460,031,000 | 80.7 |
| Wisconsin | 2,897,255,462 | 1,853,716,861 | 64.0 | 1,043,538,601 | 36.0 |
| Total | 54,819,684,825 | 30,156,771,756 | 55.0 | 24,662,913,069 | 45.0 |

## PRODUCTION OF OIL AND WATER GAS.

Since the manufacture of coke in retort ovens assumed, in 1897, an importance sufficient to be considered an independent industry, the problems regarding the supply of and the demand for the by-products obtained have created a desire for statistical data on these products as produced at gas houses; and as no other bureau of the Federal Government was charged with that duty at that time the Geological Survey undertook the preparation of the special report on the production of gas, coke, tar, and ammonia in 1898, and since 1902 the statistics have been collected each year with the exception of 1906. Similarly the statistics of coal-gas production have created a desire for information as to the production of oil and water gas, and in response to the numerous requests this information has been collected for the reports for 1905 and 1907.

In the preparation of the report for 1905 returns were received from 477 oil and water gas companies, and these show that in that year the total production of water gas was 82,959,228,504 cubic feet, of which 5,547,203,913 cubic feet, or 6.7 per cent, were lost by leakage, etc., leaving 77,412,024,591 cubic feet as the net production obtained and sold. In 1907 returns were received from 520 producing companies, and the production reported was 102,139,874,507 cubic feet, of which 7,505,261,777 cubic feet, or 7.3 per cent, were lost or unaccounted for, leaving 94,634,612,730 cubic feet as the net production. As the quantity of gas made and sold at coal-gas works and at by-product coke ovens in 1907 was 54,819,684,825 cubic feet, it appears that the consumption of water gas is nearly twice as much as that of coal gas. It also appears that while the average price of coal gas in 1907 was 67 cents per thousand cubic feet, that of oil and water gas was 95 cents per thousand cubic feet, this being due to the larger proportion of oil and water gas which is used for illuminating purposes, and also to the much lower price at which by-product oven gas is sold. The oil and water gas used for illuminating purposes in 1907 was 71,931,606,896 cubic feet, or 76 per cent, while the quantity sold for fuel purposes was 22,703,005,834, or 24 per cent, of the total.

The quantity and value of oil and water gas produced in the United States in 1905 and 1907, by States, are shown in the following table:

*Quantity and value of oil and water gas produced and sold in the United States in 1905, by States.*

| State. | Number of establishments. | Total quantity of gas produced. | Gas sold for illuminating purposes. |  |  | Gas sold for fuel purposes. |  |  | Total gas sold. |  |  | Quantity of gas unaccounted for. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. |  |
|  |  | *Cubic feet.* | *Cubic feet.* |  |  | *Cubic feet.* |  |  | *Cubic feet.* |  |  | *Cubic feet.* |
| Alabama | 2 | 744,991,632 | 352,349,229 | $488,666 | $1.38 | 325,460,504 | $450,440 | $1.38 | 677,809,733 | $939,106 | $1.38 | 67,181,899 |
| Louisiana | 2 |  |  |  |  |  |  |  |  |  |  |  |
| Mississippi | 1 |  |  |  |  |  |  |  |  |  |  |  |
| Arkansas | 3 | 72,117,810 | 39,664,660 | 62,944 | 1.59 | 32,446,740 | 42,447 | 1.30 | 72,111,400 | 105,391 | 1.46 | 6,410 |
| California | 53 | 5,581,217,182 | 3,792,705,977 | 3,691,044 | .97 | 1,559,104,387 | 1,654,558 | 1.06 | 5,351,810,364 | 5,345,602 | .99 | 229,406,818 |
| Colorado | 6 | 268,254,000 | 95,804,850 | 121,728 | 1.27 | 151,668,171 | 153,728 | 1.01 | 247,473,021 | 275,456 | 1.11 | 20,780,979 |
| Connecticut | 17 | 1,710,251,684 | 1,134,296,578 | 1,258,863 | 1.10 | 476,617,460 | 502,535 | 1.05 | 1,610,914,038 | 1,761,398 | 1.09 | 99,337,646 |
| Delaware | 2 | 3,009,307,400 | 2,207,221,196 | 2,270,032 | 1.03 | 563,486,541 | 592,710 | 1.05 | 2,770,707,737 | 2,862,742 | 1.03 | 238,599,663 |
| District of Columbia | 2 |  |  |  |  |  |  |  |  |  |  |  |
| Maryland | 6 |  |  |  |  |  |  |  |  |  |  |  |
| Florida | 9 | 152,169,400 | 83,231,606 | 156,604 | 1.88 | 66,110,405 | 104,602 | 1.58 | 149,342,011 | 261,206 | 1.74 | 2,827,389 |
| Georgia | 5 | 376,509,279 | 179,714,250 | 204,555 | 1.13 | 177,473,150 | 191,514 | 1.08 | 357,187,400 | 396,069 | 1.10 | 19,321,879 |
| Illinois | 25 | 10,331,984,080 | 6,848,075,406 | 5,947,088 | .86 | 2,626,206,962 | 2,283,386 | .86 | 9,474,282,368 | 8,230,474 | .86 | 857,701,712 |
| Indiana | 17 | 640,642,500 | 359,816,382 | 363,393 | 1.00 | 230,301,804 | 218,132 | .94 | 590,118,186 | 581,525 | .98 | 50,524,314 |
| Iowa | 22 | 831,209,584 | 440,877,502 | 525,474 | 1.19 | 352,194,388 | 411,245 | 1.16 | 793,071,890 | 936,719 | 1.18 | 38,137,694 |
| Kansas | 5 | 24,701,900 | 12,063,225 | 18,977 | 1.57 | 12,539,675 | 17,880 | 1.42 | 24,602,900 | 36,857 | 1.49 | 99,000 |
| Kentucky | 6 | 247,252,600 | 100,397,000 | 121,669 | 1.21 | 123,770,600 | 88,812 | .71 | 224,167,600 | 210,481 | .93 | 23,085,000 |
| Maine | 3 | 116,364,000 | 82,313,170 | 110,176 | 1.33 | 24,618,230 | 31,935 | 1.29 | 106,931,400 | 142,111 | 1.32 | 9,432,600 |
| Massachusetts | 33 | 3,508,309,632 | 2,919,904,984 | 2,906,412 | .99 | 457,894,916 | 471,576 | 1.03 | 3,377,799,900 | 3,377,988 | 1.00 | 130,509,732 |
| Michigan | 16 | 841,566,604 | 318,362,912 | 304,017 | .95 | 465,861,161 | 394,763 | .85 | 784,224,073 | 698,780 | .88 | 57,342,531 |
| Minnesota | 8 | 985,622,000 | 587,311,990 | 643,017 | 1.09 | 337,223,500 | 369,776 | 1.09 | 924,535,490 | 1,012,793 | 1.09 | 61,086,510 |
| Missouri | 8 | 3,428,602,800 | 1,602,557,089 | 1,609,592 | 1.00 | 1,601,320,500 | 1,350,835 | .84 | 3,203,877,589 | 2,960,427 | .92 | 224,725,211 |
| Nebraska | 7 | 593,830,960 | 237,449,770 | 304,143 | 1.28 | 318,240,541 | 398,631 | 1.25 | 555,690,311 | 702,774 | 1.26 | 38,140,649 |
| New Hampshire | 6 | 149,858,180 | 96,011,658 | 142,802 | 1.48 | 42,736,476 | 63,706 | 1.49 | 138,748,134 | 206,508 | 1.48 | 11,110,046 |
| New Jersey | 19 | 5,839,437,175 | 2,485,491,448 | 2,665,452 | 1.07 | 2,734,855,288 | 2,877,891 | 1.05 | 5,220,346,736 | 5,543,343 | 1.06 | 619,090,439 |
| New York | 56 | 30,952,263,829 | 25,696,792,789 | 25,685,762 | .99 | 3,088,930,930 | 3,226,608 | 1.04 | 28,785,723,719 | 28,912,370 | 1.00 | 2,166,540,110 |
| North Carolina | 6 | 97,608,130 | 61,640,254 | 93,803 | 1.52 | 32,195,076 | 39,885 | 1.24 | 93,835,330 | 133,688 | 1.42 | 3,772,800 |
| South Carolina | 2 |  |  |  |  |  |  |  |  |  |  |  |
| North Dakota | 1 | 79,138,000 | 35,760,100 | 62,614 | 1.75 | 35,403,000 | 55,821 | 1.58 | 71,163,100 | 118,435 | 1.66 | 7,974,900 |
| South Dakota | 3 |  |  |  |  |  |  |  |  |  |  |  |
| Ohio | 18 | 759,126,070 | 475,047,848 | 417,349 | .87 | 205,335,628 | 147,472 | .71 | 680,383,476 | 564,821 | .83 | 78,742,594 |
| Pennsylvania | 64 | 8,686,430,562 | 7,841,283,727 | 8,070,667 | 1.02 | 659,922,677 | 779,904 | 1.18 | 8,501,206,404 | 8,850,571 | 1.04 | 185,224,158 |
| Rhode Island | 6 | 804,106,000 | 464,259,200 | 537,065 | 1.15 | 277,829,200 | 280,381 | 1.00 | 742,088,400 | 817,446 | 1.10 | 62,017,600 |
| Tennessee | 3 | 279,300,000 | 122,080,300 | 120,391 | .98 | 107,520,000 | 107,373 | .99 | 229,600,300 | 227,764 | .99 | 49,699,700 |
| Texas | 7 | 321,992,690 | 93,511,709 | 141,209 | 1.51 | 196,960,719 | 277,545 | 1.40 | 290,472,428 | 418,754 | 1.44 | 31,520,262 |
| Vermont | 5 | 62,775,582 | 25,766,466 | 34,786 | 1.35 | 33,473,800 | 41,438 | 1.23 | 59,240,266 | 76,224 | 1.28 | 3,535,316 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia | 4 | 374,655,700 | 225,970,087 | 232,952 | 1.03 | 48,928,975 | 49,351 | 1.00 | 274,899,062 | 282,303 | 1.02 | 99,756,638 |
| West Virginia | 1 | | | | | | | | | | | |
| Wisconsin | 10 | 508,493,435 | 202,350,575 | 236,603 | 1.16 | 257,492,588 | 227,257 | .88 | 459,843,163 | 463,860 | 1.00 | 48,650,272 |
| Arizona | 2 | 579,138,104 | 311,720,492 | 338,233 | 1.08 | 256,096,170 | 280,281 | 1.09 | 567,816,662 | 618,514 | 1.08 | 11,321,442 |
| Nevada | 1 | | | | | | | | | | | |
| Oklahoma | 1 | | | | | | | | | | | |
| Oregon | 1 | | | | | | | | | | | |
| Utah | 1 | | | | | | | | | | | |
| Washington | 2 | | | | | | | | | | | |
| Total | 477 | 82,959,228,504 | 59,531,804,429 | 59,888,082 | 1.005 | 17,880,220,162 | 18,184,418 | 1.017 | 77,412,024,591 | 78,072,500 | 1.008 | 5,547,203,913 |

*Quantity and value of oil and water gas produced and sold in the United States in 1907, by States.*

| State. | Number of establishments. | Total quantity of gas produced. | Gas sold for illuminating purposes. | | | Gas sold for fuel purposes. | | | Total gas sold. | | | Quantity of gas unaccounted for. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | Quantity. | Value. | Price per 1,000 cubic feet. | |
| | | *Cubic feet.* | *Cubic feet.* | | | *Cubic feet.* | | | *Cubic feet.* | | | *Cubic feet.* |
| Alabama | 3 | 961,490,800 | 429,950,259 | $525,841 | $1.22 | 417,526,489 | $494,835 | $1.19 | 847,476,748 | $1,020,676 | $1.20 | 114,014,052 |
| Louisiana | 1 | | | | | | | | | | | |
| Mississippi | 2 | | | | | | | | | | | |
| Arizona | 4 | 65,017,700 | 19,781,651 | 39,972 | 2.02 | 39,520,327 | 72,604 | 1.84 | 59,301,978 | 112,576 | 1.90 | 5,715,722 |
| Arkansas | 3 | 131,807,200 | 56,846,522 | 72,847 | 1.28 | 63,733,268 | 73,917 | 1.16 | 120,579,790 | 146,764 | 1.22 | 11,227,410 |
| Oklahoma | 1 | | | | | | | | | | | |
| California | 59 | 10,029,232,139 | 6,071,446,969 | 5,867,100 | .97 | 2,144,495,935 | 1,975,306 | .92 | 8,215,942,904 | 7,842,406 | .95 | 1,813,289,235 |
| Colorado | 5 | 364,196,254 | 116,939,713 | 116,226 | .99 | 209,448,965 | 201,107 | .96 | 326,388,678 | 317,333 | .97 | 37,807,576 |
| Connecticut | 19 | 2,111,965,192 | 1,370,734,646 | 1,469,683 | 1.07 | 641,823,688 | 655,908 | 1.02 | 2,012,558,334 | 2,125,591 | 1.06 | 99,406,858 |
| Delaware | 3 | 3,722,455,600 | 2,656,585,163 | 2,671,028 | 1.01 | 785,462,586 | 763,994 | .97 | 3,442,047,749 | 3,435,022 | 1.00 | 280,407,851 |
| District of Columbia | 1 | | | | | | | | | | | |
| Maryland | 6 | | | | | | | | | | | |
| Florida | 8 | 211,418,200 | 107,599,580 | 184,641 | 1.72 | 86,417,920 | 123,653 | 1.43 | 194,017,500 | 308,294 | 1.59 | 17,400,700 |
| Georgia | 5 | 468,168,657 | 198,645,591 | 230,564 | 1.16 | 250,456,982 | 270,583 | 1.08 | 449,102,573 | 501,147 | 1.12 | 19,066,084 |
| Illinois | 27 | 11,487,448,908 | 6,870,318,164 | 5,932,773 | .86 | 3,489,893,701 | 3,094,284 | .89 | 10,360,211,865 | 9,027,057 | .87 | 1,127,237,043 |
| Indiana | 20 | 1,508,740,400 | 832,167,897 | 787,995 | .95 | 578,425,775 | 556,169 | .96 | 1,410,593,672 | 1,344,164 | .95 | 98,146,728 |
| Iowa | 29 | 1,226,951,283 | 547,352,140 | 605,824 | 1.11 | 598,732,845 | 640,687 | 1.07 | 1,146,084,985 | 1,246,511 | 1.09 | 80,866,298 |
| Kansas | 1 | 771,235,275 | 305,575,518 | 368,566 | 1.21 | 419,687,685 | 496,658 | 1.18 | 725,263,203 | 865,224 | 1.19 | 45,972,072 |
| Nebraska | 10 | | | | | | | | | | | |
| Kentucky | 6 | 304,743,000 | 128,391,600 | 136,821 | 1.07 | 139,247,648 | 100,400 | .72 | 267,639,248 | 237,221 | .89 | 37,103,752 |
| Maine | 3 | 125,472,000 | 85,933,268 | 108,269 | 1.26 | 31,741,634 | 39,209 | 1.24 | 117,674,902 | 147,478 | 1.25 | 7,797,098 |
| Massachusetts | 32 | 4,691,387,246 | 3,857,471,123 | 3,390,288 | .88 | 663,869,512 | 640,078 | .96 | 4,521,340,635 | 4,030,366 | .89 | 170,046,611 |
| Michigan | 22 | 1,331,277,548 | 582,608,826 | 594,495 | 1.02 | 648,393,450 | 535,355 | .83 | 1,231,002,276 | 1,129,850 | .92 | 100,275,272 |
| Minnesota | 8 | 1,608,153,441 | 823,138,667 | 829,697 | 1.01 | 655,524,215 | 662,199 | 1.01 | 1,478,662,882 | 1,491,896 | 1.01 | 129,490,559 |
| Missouri | 9 | 2,886,699,370 | 1,121,747,732 | 1,131,800 | 1.01 | 1,485,144,548 | 1,155,315 | .78 | 2,606,892,280 | 2,287,115 | .88 | 279,807,090 |
| Montana | 2 | 32,467,750 | 14,109,995 | 27,050 | 1.92 | 15,257,218 | 28,668 | 1.88 | 29,367,213 | 55,718 | 1.90 | 3,100,537 |
| North Dakota | 3 | | | | | | | | | | | |
| Nevada | 1 | 38,131,620 | 10,425,860 | 12,342 | 1.18 | 26,375,416 | 32,968 | 1.25 | 36,801,276 | 45,310 | 1.23 | 1,330,344 |
| New Mexico | 1 | | | | | | | | | | | |
| Utah | 1 | | | | | | | | | | | |
| New Hampshire | 10 | 194,813,082 | 125,316,784 | 186,572 | 1.49 | 52,005,308 | 76,407 | 1.47 | 177,322,092 | 262,979 | 1.48 | 17,490,990 |
| New Jersey | 23 | 6,872,615,600 | 3,351,257,752 | 3,301,383 | .99 | 2,763,107,059 | 2,725,922 | .99 | 6,114,364,811 | 6,027,305 | .99 | 758,250,789 |
| New York | 51 | 35,283,832,777 | 30,088,327,065 | 27,241,544 | .91 | 3,541,776,742 | 3,323,302 | .94 | 33,630,103,807 | 30,564,846 | .91 | 1,653,728,970 |
| North Carolina | 6 | 129,258,000 | 70,684,726 | 102,505 | 1.45 | 48,915,855 | 64,179 | 1.31 | 119,600,581 | 166,684 | 1.39 | 9,657,419 |
| South Carolina | 2 | | | | | | | | | | | |
| Ohio | 13 | 752,601,217 | 412,017,778 | 389,695 | .95 | 236,941,021 | 159,824 | .67 | 648,958,799 | 549,519 | .85 | 103,642,418 |
| Oregon | 2 | 973,409,600 | 426,182,665 | 448,266 | 1.05 | 539,168,633 | 557,612 | 1.03 | 965,351,298 | 1,005,878 | 1.04 | 8,058,302 |
| Washington | 4 | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pennsylvania | 62 | 10,651,458,070 | 9,701,190,323 | 9,896,609 | 1.02 | 756,941,331 | 843,572 | 1.11 | 10,458,131,654 | 10,740,181 | 1.02 | 193,326,416 |
| Rhode Island | 6 | 1,065,389,930 | 629,638,011 | 601,677 | .96 | 417,929,194 | 391,871 | .94 | 1,047,567,205 | 993,548 | .95 | 17,822,725 |
| South Dakota | 5 | 99,276,805 | 49,795,690 | 77,599 | 1.56 | 46,973,010 | 65,974 | 1.40 | 96,768,700 | 143,573 | 1.48 | 2,508,105 |
| Tennessee | 3 | 365,781,400 | 137,701,621 | 137,702 | 1.00 | 161,596,319 | 161,603 | 1.00 | 299,297,940 | 299,305 | 1.00 | 66,483,460 |
| Texas | 10 | 591,644,500 | 191,529,803 | 259,309 | 1.35 | 335,849,977 | 426,797 | 1.27 | 527,379,780 | 686,106 | 1.30 | 64,264,720 |
| Vermont | 7 | 115,612,800 | 47,654,940 | 63,977 | 1.34 | 65,711,360 | 87,155 | 1.33 | 113,366,300 | 151,132 | 1.33 | 2,246,500 |
| Virginia | 5 | 542,933,200 | 340,731,924 | 345,488 | 1.01 | 96,508,020 | 101,354 | 1.05 | 437,239,944 | 446,842 | 1.02 | 105,093,256 |
| West Virginia | 2 | | | | | | | | | | | |
| Wisconsin | 11 | 422,787,943 | 151,806,930 | 167,688 | 1.10 | 248,402,198 | 249,807 | 1.01 | 400,209,128 | 417,495 | 1.04 | 22,578,815 |
| Total | 520 | 102,139,874,507 | 71,931,606,896 | 68,323,836 | .95 | 22,703,005,834 | 21,849,276 | .96 | 94,634,612,730 | 90,173,112 | .95 | 7,505,261,777 |

## PRODUCTION OF COKE.

The total quantity of coke produced in by-product recovery coke ovens and at gas works in 1907 amounted to 8,093,144 short tons, valued at $30,332,644, as against 5,751,378 short tons, valued at $18,844,866, in 1905. The increase in the production of coke was 2,341,766 short tons, or 41 per cent, while the value increased $11,487,778, or 61 per cent. The increase in the production of coke was almost entirely in the output from by-product ovens, the quantity of by-product coke having increased from 3,462,348 short tons in 1905 to 5,583,038 short tons in 1907, a gain of 2,120,690 short tons, or 61 per cent, while the production of gas-house coke showed an increase of only 221,076 short tons, or 10 per cent, from 2,289,030 short tons in 1905 to 2,510,106 short tons in 1907. This larger proportionate production of by-product coke in 1907 was responsible also for the greater percentage of increase in value, by-product coke being a metallurgical fuel and commanding in the same markets a much higher price than the gas-house product. The average price for gas-house and by-product coke increased from $3.28 in 1905 to $3.75 in 1907. The total value of the 5,583,038 short tons of by-product coke included in the total production was $21,602,680, an average of $3.87 per ton, while the value of the 2,510,106 tons of gas-house coke was $8,729,964, or an average of $3.48 per ton.

The total quantity of coal carbonized or coked at gas works and in by-product ovens in 1907 was 11,490,661 short tons, of which 7,460,587 short tons were coked in by-product recovery ovens and 4,030,074 tons were used at gas works. In 1905 there were 8,187,812 short tons of coal carbonized, of which 4,628,981 short tons were coked in retort ovens and 3,558,831 tons were used at gas works. In 1904 the amount of coal carbonized was almost equally divided between the coke ovens and gas works. The yield of coal in coke in by-product recovery ovens in 1907 was 75 per cent. The quantity of gas-house coke produced in 1907 was 62 per cent of the coal carbonized.

Many gas companies are engaged also in the electric-light business, and coke produced at the gas works, as well as a considerable quantity of tar, is used for firing in the electric-light plants. Other coal-gas producers are also producers of water gas, and the coke from the coal benches is used for firing the water-gas plant. Some coke is also used in the carbonization of coal at some of the gas works. This is to be noted in the cases where the companies did not report any coke produced. The total production is given as nearly as possible in these reports, the quantity consumed being arrived at as accurately as possible, and the value placed upon it is the same as that received for the coke sold.

The following table gives the production of coke at the gas works and by-product ovens, by States and Territories, arranged according to their rank in producing importance.

*Rank of States in production of coke in gas works and by-product ovens in 1905 and 1907.*

### 1905.

| Rank. | State. | Number of establishments. | Quantity. | Value. | Value per ton. | Yield of coal in coke. |
|---|---|---|---|---|---|---|
| | | | *Short tons.* | | | *Per cent.* |
| 1 | Pennsylvania | 30 | 1,374,815 | $3,903,634 | $2.84 | 73.0 |
| 2 | Massachusetts | 44 | 670,542 | 2,247,074 | 3.35 | 71.3 |
| 3 | Ohio | 40 | 497,208 | 1,446,387 | 2.91 | 71.6 |
| 4 | Michigan | 42 | 470,718 | 1,592,253 | 3.38 | 75.0 |
| 5 | New York | 51 | 423,167 | 1,335,345 | 3.15 | 61.3 |
| 6 | District of Columbia and Maryland | 8 | 406,764 | 1,334,266 | 3.28 | 75.2 |
| 7 | Alabama | 10 | [a] 384,206 | 1,157,987 | 3.01 | 70.8 |
| 8 | Wisconsin | 20 | 293,759 | 1,252,106 | 4.26 | 74.9 |
| 9 | New Jersey | 16 | 191,824 | 643,984 | 3.35 | 73.9 |
| 10 | Minnesota | 8 | 134,670 | 569,964 | 4.23 | 70.6 |
| 11 | Illinois | 41 | 129,564 | 487,772 | 3.76 | 59.5 |
| 12 | Missouri | 19 | 124,886 | 439,920 | 3.52 | 64.1 |
| 13 | West Virginia | 6 | 119,369 | 415,468 | 3.48 | 70.4 |
| 14 | Indiana | 33 | 90,927 | 303,354 | 3.34 | 60.8 |
| 15 | Kentucky | 12 | 56,328 | 183,100 | 3.25 | 69.3 |
| 16 | Iowa | 16 | 39,369 | 179,533 | 4.56 | 63.6 |
| 17 | Tennessee | 8 | 39,159 | 135,790 | 3.47 | 61.2 |
| 18 | Connecticut | 7 | 37,958 | 133,407 | 3.51 | 62.5 |
| 19 | Colorado | 5 | 35,089 | 140,673 | 4.01 | 66.1 |
| 20 | Rhode Island | 3 | 34,868 | 135,018 | 3.87 | 64.8 |
| 21 | Georgia | 9 | 34,720 | 101,181 | 2.91 | 64.0 |
| 22 | Virginia | 13 | 32,422 | 116,879 | 3.60 | 58.2 |
| 23 | Washington | 7 | 28,006 | 109,032 | 3.89 | 68.9 |
| 24 | New Hampshire and Vermont | 7 | 14,095 | 74,863 | 5.31 | 64.1 |
| 25 | Texas | 9 | 11,984 | 54,531 | 4.55 | 63.2 |
| 26 | South Carolina | 3 | 11,823 | 42,992 | 3.64 | 80.8 |
| 27 | Maine | 7 | 10,746 | 51,253 | 4.77 | 62.7 |
| 28 | Kansas | 7 | 9,749 | 35,260 | 3.62 | 50.9 |
| 29 | Idaho, North Dakota, South Dakota, Utah, and Wyoming | 8 | 7,462 | 42,923 | 5.75 | 48.4 |
| 30 | Florida, Louisiana, and Mississippi | 7 | 6,180 | 26,313 | 4.26 | 60.8 |
| 31 | North Carolina | 6 | 5,373 | 29,253 | 5.44 | 52.6 |
| 32 | Nebraska | 3 | 4,916 | 26,135 | 5.32 | 63.5 |
| 33 | Delaware | 3 | 4,128 | 12,740 | 3.09 | 53.0 |
| 34 | Montana, Nevada, and New Mexico | 4 | 4,017 | 26,348 | 6.55 | 49.0 |
| 35 | Arkansas | 4 | 3,894 | 16,247 | 4.17 | 62.5 |
| 36 | Indian Territory and Oklahoma | 5 | 3,636 | 16,551 | 4.55 | 55.0 |
| 37 | California | 3 | 1,710 | 16,384 | 9.58 | 53.6 |
| | Oregon | 3 | 1,327 | 8,946 | 6.74 | 58.5 |
| | Total | 527 | 5,751,378 | 18,844,866 | 3.28 | 70.25 |

[a] In addition 438 tons were produced and unsold, there being no market for it.

*Rank of States in production of coke in gas works and by-product ovens in 1905 and 1907*—Continued.

1907.

| Rank. | State. | Number of establishments. | Quantity. | Value. | Value per ton. | Yield of coal in coke. |
|---|---|---|---|---|---|---|
| | | | *Short tons.* | | | *Per cent.* |
| 1 | Pennsylvania | 27 | 2,165,066 | $8,311,285 | $3.84 | 75.0 |
| 2 | New York | 47 | 978,057 | 3,859,398 | 3.95 | 68.5 |
| 3 | Massachusetts | 42 | 698,049 | 2,404,522 | 3.44 | 69.9 |
| 4 | Wisconsin | 21 | 534,040 | 2,572,896 | 4.82 | 75.7 |
| 5 | Ohio | 30 | 529,650 | 1,222,842 | 2.31 | 73.6 |
| 6 | Michigan | 46 | 527,276 | 2,076,151 | 3.94 | 71.1 |
| 7 | Illinois | 41 | 521,396 | 2,339,702 | 4.49 | 68.8 |
| 8 | Alabama | 10 | 486,603 | 1,482,717 | 3.05 | 68.6 |
| 9 | Delaware, District of Columbia, and Maryland | 8 | 364,477 | 1,558,085 | 4.27 | 70.8 |
| 10 | New Jersey | 14 | 307,844 | 915,169 | 2.97 | 73.0 |
| 11 | Virginia and West Virginia | 15 | 202,805 | 600,521 | 2.96 | 70.1 |
| 12 | Minnesota | 9 | 135,967 | 532,166 | 3.91 | 66.2 |
| 13 | Missouri | 14 | 114,748 | 421,566 | 3.67 | 58.2 |
| 14 | Indiana | 28 | 84,181 | 276,154 | 3.28 | 60.3 |
| 15 | Kentucky | 11 | 65,087 | 169,591 | 2.61 | 66.5 |
| 16 | Colorado | 7 | 48,552 | 183,705 | 3.78 | 65.4 |
| 17 | Rhode Island | 3 | 43,096 | 152,713 | 3.54 | 75.8 |
| 18 | Connecticut | 7 | 42,583 | 154,792 | 3.64 | 58.1 |
| 19 | Georgia | 8 | 41,776 | 142,346 | 3.41 | 62.3 |
| 20 | Tennessee | 6 | 40,043 | 125,793 | 3.14 | 60.4 |
| 21 | Iowa | 17 | 39,432 | 193,804 | 4.91 | 57.0 |
| 22 | Washington | 9 | 36,507 | 199,179 | 5.46 | 62.8 |
| 23 | North Carolina and South Carolina | 6 | 16,872 | 75,021 | 4.45 | 64.9 |
| 24 | New Hampshire and Vermont | 6 | 12,521 | 69,711 | 5.57 | 61.7 |
| 25 | Texas | 6 | 12,049 | 56,407 | 4.68 | 56.5 |
| 26 | Maine | 7 | 10,385 | 46,058 | 4.44 | 51.2 |
| 27 | Idaho, Montana, North Dakota, South Dakota, and Wyoming | 9 | 9,863 | 72,692 | 7.37 | 51.2 |
| 28 | Florida, Louisiana, and Mississippi | 8 | 6,483 | 26,497 | 4.09 | 61.8 |
| 29 | Nevada, New Mexico, and Utah | 4 | 5,678 | 31,753 | 5.59 | 48.2 |
| 30 | Kansas and Nebraska | 5 | 4,774 | 23,893 | 5.00 | 33.6 |
| 31 | Arkansas | 3 | 3,962 | 18,152 | 4.58 | 62.9 |
| 32 | Oklahoma | 4 | 2,411 | 11,296 | 4.69 | 25.1 |
| 33 | Oregon | 3 | 911 | 6,067 | 6.66 | 61.8 |
| | Total | 481 | 8,093,144 | 30,332,644 | 3.75 | 70.7 |

## PRODUCTION OF COAL TAR.

Coal tar, as the raw material from which is obtained creosoting oils, aniline dyes, and salts, and innumerable organic chemical compounds and medicinal preparations, is of much more economic importance in some of the European countries than it is in the United States. This country is considerably in the rear, particularly when compared with Germany, in the development of chemical industries based on coal tar, the products of which are imported to the value of several million dollars each year. At the present time coal-tar manufacture in the United States is confined principally to the production of creosote and of tars and tar pitches suitable for roofing papers, paving materials, etc. With the continued development of the retort-oven coking industry, however, and an assured supply of coal tar, there is every reason to believe that chemical industries dependent upon tar as a raw material will be established. The lack of such an outlet for one of the principal by-products of retort-oven coke manufacture is in part responsible for the fact that the construction of by-product oven plants has not been more energetically pushed in this country.

The total production of coal tar, as reported to the Geological Survey in 1907 by 488 companies, was 103,577,760 gallons, valued at $2,651,527, as against a production of 80,022,043 gallons, valued at $2,176,944, reported in 1905 by 521 companies, from which it appears that while the production of coal tar increased 23,555,717 gallons, or 29 per cent, the value increased only $474,583, or 22 per cent. The average price per gallon decreased from 2.72 cents in 1905 to 2.6 cents in 1907. The price for tar has shown a steadily declining tendency since 1903, when the average price reported to the Survey was 3.49 cents per gallon. It dropped to 3.04 cents in 1904, to 2.72 cents in 1905, and to 2.6 cents in 1907. The yield of tar per ton of coal consumed in 1907 ranged from 6.34 gallons in Pennsylvania to 19.63 gallons in Missouri. The price ranged from 2 cents in Illinois to 10.3 cents in Oregon. The average yield of tar per ton of coal for the entire United States was 9.04 gallons. In 1905 the average yield of tar was 9.79 gallons per ton of coal consumed.

The following tables show the production of coal tar in the United States in 1905 and 1907, arranged according to rank of States:

*Rank of States in coal-tar production in 1905 and 1907.*

1905.

| Rank. | State. | Number of establishments. | Quantity. | Value. | Value per gallon. | Yield per ton of coal. |
|---|---|---|---|---|---|---|
| | | | *Gallons.* | | *Cents.* | *Gallons.* |
| 1 | Pennsylvania | 30 | 14,249,781 | $319,201 | 2.24 | 7.5 |
| 2 | Massachusetts | 43 | 10,017,517 | 285,666 | 2.85 | 10.65 |
| 3 | Ohio | 38 | 8,479,198 | 270,325 | 3.19 | 12.23 |
| 4 | New York | 51 | 7,349,569 | 189,866 | 2.6 | 10.65 |
| 5 | Michigan | 41 | [a] 5,958,602 | 116,809 | 1.9 | 9.6 |
| 6 | Alabama | 10 | [b] 4,592,516 | 128,271 | 2.8 | 8.5 |
| 7 | District of Columbia and Maryland | 8 | 4,155,460 | 87,512 | 2 | 7.7 |
| 8 | Wisconsin | 20 | 3,905,217 | 94,305 | 2.4 | 9.96 |
| 9 | New Jersey | 16 | 2,774,725 | 84,243 | 3 | 10.69 |
| 10 | Missouri | 19 | 2,486,575 | 86,515 | 3.48 | 12.87 |
| 11 | Illinois | 41 | 2,415,023 | 49,714 | 2.05 | 11.09 |
| 12 | Minnesota | 8 | 2,111,053 | 54,823 | 2.6 | 11.07 |
| 13 | West Virginia | 6 | 1,766,066 | 50,542 | 2.8 | 10.42 |
| 14 | Indiana | 32 | [c] 1,712,397 | 44,198 | 2.58 | 11.45 |
| 15 | Kentucky | 12 | 959,293 | 17,942 | 1.87 | 11.8 |
| 16 | Tennessee | 8 | 721,411 | 29,663 | 4 | 11.3 |
| 17 | Georgia | 9 | 712,799 | 24,604 | 3.45 | 13.15 |
| 18 | Connecticut | 7 | 712,328 | 35,980 | 5 | 11.64 |
| 19 | Rhode Island | 3 | 710,069 | 20,400 | 2.8 | 13.2 |
| 20 | Colorado | 5 | 698,527 | 26,758 | 3.8 | 13.15 |
| 21 | Virginia | 13 | 691,530 | 21,152 | 3.06 | 12.4 |
| 22 | Iowa | 16 | 633,508 | 14,775 | 2.3 | 10.24 |
| 23 | Washington | 7 | 465,380 | 32,268 | 6.9 | 11.45 |
| 24 | New Hampshire and Vermont | 7 | 265,556 | 13,177 | 4.96 | 12.07 |
| 25 | Texas | 10 | 236,341 | 15,140 | 6.4 | 12.35 |
| 26 | Maine | 7 | 212,445 | 9,983 | 4.7 | 12.4 |
| 27 | Kansas | 7 | 205,690 | 10,898 | 5.3 | 10.74 |
| 28 | South Carolina | 3 | 158,361 | 5,315 | 3.3 | 10.8 |
| 29 | Montana Nevada, and New Mexico | 4 | 89,226 | 3,496 | 3.9 | 10.89 |
| 30 | Florida, Louisiana, and Mississippi | 7 | 87,236 | 5,710 | 6.5 | 8.6 |
| 31 | Idaho, North Dakota, South Dakota, Utah, and Wyoming | 6 | [d] 85,458 | 6,830 | 8 | 7.8 |
| 32 | Nebraska | 3 | 82,393 | 2,426 | 2.9 | 10.64 |
| 33 | Delaware | 3 | 76,606 | 2,725 | 3.557 | 9.9 |
| 34 | North Carolina | 6 | 74,503 | 4,355 | 5.8 | 7.3 |
| 35 | Arkansas | 4 | 66,900 | 3,677 | 5.5 | 10.74 |
| 36 | Indian Territory and Oklahoma | 5 | 54,002 | 3,323 | 6.15 | 8.2 |
| 37 | California | 3 | 27,220 | 2,212 | 8 | 8.5 |
| 38 | Oregon | 3 | 21,452 | 2,145 | 10 | 9.4 |
| | Total | 521 | 80,022,043 | 2,176,944 | 2.72 | 9.79 |

[a] In addition 53,526 gallons were produced and unsold, there being no market for it.
[b] In addition 52,000 gallons were produced and unsold, there being no market for it.
[c] In addition 12,914 gallons were produced and unsold, there being no market for it.
[d] In addition 43,725 gallons were produced and unsold, there being no market for it.

*Rank of States in coal-tar production in 1905 and 1907*—Continued.

1907.

| Rank. | State. | Number of establishments. | Quantity. | Value. | Value per gallon. | Yield per ton of coal. |
|---|---|---|---|---|---|---|
| | | | *Gallons.* | | *Cents.* | *Gallons.* |
| 1 | Pennsylvania | 28 | 18,304,661 | $412,127 | 2.3 | 6.34 |
| 2 | New York | 50 | 13,769,436 | 302,290 | 2.2 | 9.58 |
| 3 | Massachusetts | 41 | 10,659,792 | 299,219 | 2.8 | 10.72 |
| 4 | Ohio | 32 | 8,095,305 | 218,966 | 2.7 | 11.23 |
| 5 | Michigan | 44 | 8,038,584 | 173,599 | 2.2 | 10.86 |
| 6 | Illinois | 40 | 6,383,125 | 125,049 | 2.0 | 8.49 |
| 7 | Alabama | 11 | 5,898,064 | 177,879 | 3.0 | 8.31 |
| 8 | Wisconsin | 21 | 5,436,098 | 129,556 | 2.4 | 7.70 |
| 9 | Delaware, District of Columbia, and Maryland | 10 | 4,208,105 | 86,445 | 2.1 | 8.12 |
| 10 | New Jersey | 15 | 3,973,251 | 121,049 | 3.1 | 9.40 |
| 11 | Missouri | 14 | 3,870,388 | 90,452 | 2.3 | 19.63 |
| 12 | Virginia and West Virginia | 16 | 3,094,593 | 93,558 | 3.0 | 16.95 |
| 13 | Minnesota | 8 | 2,388,283 | 70,082 | 2.9 | 11.88 |
| 14 | Indiana | 29 | 1,498,434 | 36,049 | 2.4 | 10.71 |
| 15 | Kentucky | 11 | 976,622 | 22,577 | 2.3 | 9.98 |
| 16 | Connecticut | 7 | 886,359 | 32,114 | 3.6 | 12.09 |
| 17 | Colorado | 7 | 861,799 | 40,700 | 4.7 | 11.62 |
| 18 | Iowa | 18 | 759,317 | 18,906 | 2.5 | 10.98 |
| 19 | Tennessee | 7 | 754,135 | 27,233 | 3.6 | 11.31 |
| 20 | Rhode Island | 3 | 644,026 | 17,536 | 2.7 | 11.33 |
| 21 | Georgia | 8 | 635,889 | 18,738 | 2.9 | 9.48 |
| 22 | Washington | 9 | 634,491 | 44,804 | 7.1 | 10.91 |
| 23 | Maine | 7 | 295,034 | 11,349 | 3.8 | 14.54 |
| 24 | North Carolina and South Carolina | 7 | 291,871 | 11,792 | 4.0 | 10.53 |
| 25 | New Hampshire and Vermont | 5 | 235,324 | 11,388 | 4.8 | 11.94 |
| 26 | Texas | 7 | 225,394 | 12,707 | 5.6 | 7.97 |
| 27 | Oklahoma | 5 | 193,531 | 14,275 | 7.4 | 8.56 |
| 28 | Idaho, Montana, North Dakota, and Wyoming | 6 | 144,411 | 9,831 | 6.8 | 9.93 |
| 29 | Nevada, New Mexico, and Utah | 4 | 120,925 | 7,431 | 6.1 | 10.25 |
| 30 | Kansas and Nebraska | 5 | 113,522 | 4,082 | 3.6 | 7.99 |
| 31 | Florida, Louisiana, and Mississippi | 7 | 95,870 | 3,955 | 4.1 | 10.60 |
| 32 | Arkansas | 3 | 71,700 | 3,771 | 5.3 | 11.38 |
| 33 | Oregon | 3 | 19,421 | 1,998 | 10.3 | 13.17 |
| | Total | 488 | 103,577,760 | 2,651,527 | 2.6 | 9.04 |

## PRODUCTION OF WATER-GAS TAR.

The quantity of tar produced at water-gas works in 1907 amounted to 14,414,017 gallons, valued at $342,041, against 9,230,411 gallons, valued at $245,252, in 1905. There were 69 companies which reported a marketable product of water-gas tar in 1907. At many of the plants there is no market whatsoever for the product, and it is used for fuel at the works, no record being kept of the output. Where companies produce both coal and water gas the water-gas tar, if sold at all, brings a lower price per gallon than coal-gas tar. It is interesting to note that the United Gas Improvement Company of Philadelphia, at its works at Point Breeze, is using, in the coal-briquetting plant, pitch made from water-gas tar.

The following table gives approximately the quantity of water-gas tar produced and sold in the United States in 1905 and 1907, with the total value and the average price received for it at the works:

*Quantity and value of tar produced and sold at water-gas and crude-oil works in the United States in 1905 and 1907.*

### 1905.

| State. | Total quantity. | Total value. | Price per gallon. |
|---|---|---|---|
| | *Gallons.* | | *Cents.* |
| Arkansas | 3,600 | $360 | 10 |
| California | 1,848,372 | 65,731 | 3.5 |
| Colorado and Oregon | 232,031 | 14,202 | 6.1 |
| Connecticut | 160,250 | 3,045 | 1.9 |
| Florida | 35,807 | 583 | 1.6 |
| Georgia and South Carolina | 14,254 | 577 | 4 |
| Illinois | 5,000 | 300 | 6 |
| Iowa | 146,856 | 3,645 | 2.5 |
| Kansas | 1,500 | 150 | 10 |
| Louisiana and Mississippi | 474,174 | 14,550 | 3.1 |
| Maryland | 10,000 | 1,000 | 10 |
| Massachusetts | 1,380,726 | 38,454 | 2.7 |
| Minnesota | 283,099 | 8,493 | 3 |
| Nebraska | 321,967 | 7,097 | 2.2 |
| Missouri | 6,200 | 320 | 5 |
| New Hampshire | 14,332 | 143 | 1 |
| New York | 3,990,090 | 79,736 | 2 |
| Ohio | 600 | 30 | 5 |
| Pennsylvania | 277,274 | 5,621 | 2 |
| Texas | 23,900 | 1,195 | 5 |
| Vermont | 379 | 20 | 5.3 |
| Total | [a] 9,230,411 | 245,252 | 2.66 |

### 1907.

| State. | Total quantity. | Total value. | Price per gallon. |
|---|---|---|---|
| **Arkansas, Florida, Louisiana, and Mississippi** | **440,563** | **$13,396** | **3.0** |
| **California and Washington** | **3,388,891** | **78,554** | **2.3** |
| **Connecticut and Massachusetts** | **2,142,476** | **58,914** | **2.7** |
| **Delaware, Maryland, and New Jersey** | **1,871,500** | **45,850** | **2.4** |
| **Georgia and South Carolina** | **34,439** | **2,262** | **6.6** |
| **Illinois, Indiana, and Ohio** | **132,300** | **2,675** | **2.0** |
| **Iowa** | **294,182** | **7,031** | **2.4** |
| **Minnesota and Wisconsin** | **664,457** | **21,699** | **3.2** |
| **Nebraska and South Dakota** | **454,314** | **11,205** | **2.4** |
| **Missouri** | **3,050** | **163** | **5.3** |
| **New Hampshire** | **58,120** | **777** | **1.3** |
| **New York** | **3,619.788** | **72,626** | **2.0** |
| **Pennsylvania** | **1,207,156** | **24,152** | **2.0** |
| **Texas** | **102,781** | **2,737** | **2.7** |
| Total | **14,414,017** | **342,041** | **2.4** |

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[a] **In addition 2,274,891 gallons were produced and unsold.**

## PRODUCTION OF AMMONIA.

Only about one-fifth of the establishments producing gas and coke from coal report the recovery of ammonia either in the form of ammoniacal liquor, anhydrous ammonia, or ammonium sulphate. In making the reports on the quantity of ammonia liquor produced, somewhat different methods were employed. Some companies reported the production in liquor ounces selling at a certain price per 100 liquor ounces of a specific strength; others reported the production in gallons, sales being made at a certain price per pound or by the ammonia ($NH_3$) contained; others reported the production in gallons of ammonia liquor at so much per gallon, according to the strength of the liquor. Then, again, the strength of the liquor is reported by some producers in ounces, by others in degrees Twaddell, and by still others in the percentage of anhydrous ammonia ($NH_3$). In compiling the statistics for 1907 a separate statement has been prepared of the anhydrous ammonia produced, and to this extent in the following table the figures for 1907 differ from those of 1905, in which all of the ammonia not sold as sulphate was included in the production of ammoniacal liquor. The production of ammoniacal liquor in 1907 amounted to 54,065,541 gallons (equivalent to 20,993,863 pounds of anhydrous ammonia). In addition to this the andydrous ammonia reported as such was 16,566,995 pounds, valued at $1,472,881, making a total of anhydrous ammonia of 37,560,858 pounds, valued at $2,601,057. In 1905 the total quantity of anhydrous ammonia produced and contained in the liquor was 22,455,857 pounds, valued at $1,728,254.

In the following table giving the production of ammoniacal liquor in 1905 and 1907 the returns are graded according to the strength of the ammonia liquor produced and not by States. This is done to avoid disclosing the operations of individual producers. The production of sulphate in 1907 amounted to 48,882,237 pounds, valued at $1,525,472, as against 38,663,682 pounds, valued at $997,452, in 1905.

*Production and value of ammoniacal liquor at gas and by-product coke works of the United States in 1905 and 1907.*

### 1905.

| Coal carbonized. | Quantity of ammonia liquor made and sold. | Strength of liquor. | | | | Total value of ammonia liquor. |
|---|---|---|---|---|---|---|
| | | In ounces. | Equivalent to anhydrous ammonia ($NH_3$). | | Equivalent to sulphate of ammonia (ounces per gallon). | |
| | | | Ounces per gallon. | Total in pounds. | | |
| *Short tons.* | *Gallons.* | | | | | |
| 197,577 | 8,227,916 | 2.78 | 0.97 | 497,275 | 3.76 | $18,299 |
| 7,470 | 815,740 | 3.5 | 1.22 | 62,098 | 4.73 | 2,855 |
| 18,189 | 636,615 | 4.00 | 1.39 | 55,306 | 5.40 | 1,273 |
| 30,324 | 645,646 | 4.8 | 1.67 | 67,389 | 6.48 | 5,165 |
| 11,551 | 349,141 | 4.86 | 1.69 | 36,878 | 6.56 | 1,018 |
| 58,945 | 1,866,517 | 5.00 | 1.74 | 202,984 | 6.75 | 9,219 |
| 44,126 | 1,685,918 | 5.99 | 2.08 | 219,591 | 8.07 | 11,091 |
| 66,810 | 1,646,584 | 6.00 | 2.09 | 215,085 | 8.10 | 10,373 |
| 139,819 | 4,816,260 | 6.9 | 2.40 | 722,439 | 9.31 | 54,183 |
| 39,605 | 1,395,940 | 7.00 | 2.44 | 212,445 | 9.45 | 7,277 |
| 147,000 | 46,853 | 7.2 | 2.51 | 7,350 | 9.72 | 515 |
| 39,102 | 1,206,336 | 7.23 | 2.52 | 189,621 | 9.78 | 7,564 |
| 42,013 | 1,680,502 | 8.00 | 2.78 | 291,987 | 10.80 | 12,604 |
| 256,797 | 9,082,653 | 8.62 | 3.00 | 1,702,429 | 11.64 | 66,303 |
| 8,728 | 81,507 | 9.4 | 3.27 | 16,658 | 12.69 | 880 |
| 34,636 | 440,158 | 10.00 | 3.48 | 95,726 | 13.50 | 9,227 |
| 12,523 | 43,192 | 15.2 | 5.29 | 14,275 | 20.53 | 928 |
| 235,055 | 2,389,859 | 16.00 | 5.57 | 831,674 | 21.60 | 38,533 |
| 10,625 | 37,517 | 32.00 | 11.14 | 26,121 | 43.20 | 1,151 |
| 3,692 | 7,925 | 35.52 | 12.36 | 6,122 | 47.95 | 429 |
| 5,595 | 12,300 | 38.00 | 13.22 | 10,163 | 51.29 | 620 |
| 16,304 | 36,205 | 40.00 | 13.92 | 31,498 | 53.99 | 2,471 |
| 14,022 | 35,056 | 44.00 | 15.31 | 33,544 | 59.39 | 4,319 |
| 34,716 | 58,767 | 48.00 | 16.70 | 61,338 | 64.79 | 3,394 |
| 20,507 | 18,250 | 51.64 | 17.97 | 20,497 | 69.72 | 1,694 |
| 13,426 | 52,566 | 52.00 | 18.09 | 59,421 | 70.19 | 3,565 |
| 13,944 | 36,435 | 53.2 | 18.51 | 42,151 | 71.82 | 2,180 |
| 15,255 | 56,552 | 54.00 | 18.79 | 66,414 | 72.89 | 5,313 |
| 2,578 | 3,200 | 56.00 | 19.48 | 3,896 | 75.58 | 438 |
| 3,512 | 6,965 | 56.4 | 19.62 | 8,792 | 76.13 | 615 |
| 17,168 | 38,785 | 58.00 | 20.18 | 48,918 | 78.29 | 2,835 |
| 387,763 | 1,192,976 | 60.00 | 20.87 | 1,556,088 | 80.99 | 124,303 |
| 145,515 | 412,550 | 60.2 | 20.94 | 539,925 | 81.25 | 44,019 |
| 6,828 | 14,596 | 62.00 | 21.57 | 19,677 | 83.69 | 1,082 |
| 27,880 | 51,823 | 63.12 | 21.96 | 71,124 | 85.20 | 4,809 |
| 8,797 | 27,261 | 64.00 | 22.26 | 37,927 | 86.39 | 2,845 |
| 42,500 | 162,870 | 64.56 | 22.46 | 228,628 | 87.14 | 20,577 |
| 11,516 | 29,748 | 65.00 | 22.61 | 42,038 | 87.74 | 2,943 |
| 80,720 | 294,097 | 65.48 | 22.78 | 418,720 | 88.39 | 41,872 |
| 65,925 | 170,011 | 66.48 | 23.13 | 245,772 | 89.74 | 16,098 |
| 52,444 | 93,902 | 66.66 | 23.19 | 136,100 | 89.98 | 9,527 |
| 142,262 | 267,201 | 68.8 | 23.94 | 399,799 | 92.89 | 30,031 |
| 59,836 | 174,407 | 70.00 | 24.35 | 265,426 | 94.48 | 24,552 |
| 864,966 | 1,108,205 | 70.7 | 24.60 | 1,731,023 | 95.45 | 135,474 |
| | | 71.4 | 24.84 | | 96.38 | |
| | | 72.00 | 25.05 | | 97.19 | |
| 240,426 | 709,350 | 72.44 | 25.20 | 1,156,733 | 97.78 | 90,393 |
| | | 73.00 | 25.40 | | 98.55 | |
| | | 76.72 | 26.69 | | 103.56 | |
| 558,717 | 1,425,076 | 78.00 | 27.14 | 2,587,567 | 105.30 | 246,813 |
| | | 80.00 | 27.83 | | 107.98 | |
| | | 84.96 | 29.56 | | 114.69 | |
| 1,091,006 | 1,388,615 | 85.56 | 29.77 | 2,700,849 | 115.50 | 241,049 |
| | | 92.4 | 32.15 | | 124.74 | |
| | | 96.08 | 33.43 | | 129.71 | |
| 950,068 | 2,005,730 | 100.00 | 34.79 | 4,458,376 | 134.99 | 405,536 |
| | | 102.28 | 35.58 | | 138.05 | |
| | | 102.72 | 35.74 | | 138.67 | |
| | | 113.44 | 39.47 | | 153.14 | |
| 6,298,783 | 46,986,268 | .......... | .......... | 22,455,857 | .......... | 1,728,254 |

*Production and value of ammoniacal liquor at gas and by-product coke works of the United States in 1905 and 1907*—Continued.

1907.

| Coal carbonized. | Quantity of ammonia liquor made and sold. | Strength of liquor. | | | | Total value of ammonia liquor. |
|---|---|---|---|---|---|---|
| | | In ounces. | Equivalent to anhydrous ammonia ($NH_3$). | | Equivalent to sulphate of ammonia (ounces per gallon). | |
| | | | Ounces per gallon. | Total in pounds. | | |
| *Short tons.* | *Gallons.* | | | | | |
| 14,190 | 595,200 | 4.00 | 1.39 | 51,782 | 5.40 | $1,905 |
| 45,237 | 1,998,820 | 4.74 | 1.65 | 206,004 | 6.40 | 10,422 |
| 49,396 | 1,612,560 | 5.00 | 1.74 | 175,366 | 6.75 | 7,820 |
| 255,563 | 8,511,300 | 5.37 | 1.87 | 993,694 | 7.25 | 36,532 |
| 163,915 | 2,667,712 | 6.00 | 2.09 | 347,969 | 8.10 | 15,348 |
| 155,230 | 5,964,915 | 6.06 | 2.11 | 785,878 | 8.18 | 59,649 |
| 35,179 | 1,175,265 | 6.50 | 2.26 | 166,080 | 8.77 | 6,596 |
| 33,569 | 1,241,076 | 7.00 | 2.44 | 188,876 | 9.45 | 9,304 |
| 190,375 | 4,309,565 | 8.00 | 2.78 | 749,595 | 10.80 | 54,558 |
| 239,511 | 8,656,112 | 8.17 | 2.84 | 1,537,542 | 11.03 | 57,996 |
| 85,847 | 3,458,725 | 8.18 | 2.85 | 615,221 | 11.04 | 227,238 |
| 36,466 | 827,643 | 8.45 | 2.94 | 152,079 | 11.41 | 10,950 |
| 36,440 | 331,074 | 10.00 | 3.48 | 71,988 | 13.50 | 3,234 |
| 10,527 | 143,911 | 10.20 | 3.55 | 91,743 | 13.77 | 1,655 |
| 20,541 | 157,006 | 12.00 | 4.18 | 40,969 | 16.20 | 2,465 |
| 238,238 | 2,468,749 | 16.00 | 5.57 | 858,815 | 21.60 | 40,990 |
| 8,809 | 10,080 | 24.00 | 8.35 | 5,261 | 32.40 | 252 |
| 42,463 | 186,302 | 30.00 | 10.44 | 121,562 | 40.51 | 14,281 |
| 9,932 | 19,425 | 32.00 | 11.13 | 13,513 | 43.18 | 1,098 |
| 26,124 | 391,539 | 36.00 | 12.52 | 306,380 | 48.58 | 9,124 |
| 130,525 | 664,290 | 40.00 | 13.92 | 577,933 | 54.01 | 40,265 |
| 11,623 | 25,767 | 44.00 | 15.31 | 24,656 | 59.40 | 1,972 |
| 8,969 | 18,928 | 46.00 | 16.00 | 18,928 | 62.08 | 1,230 |
| 3,536 | 2,481 | 46.20 | 16.07 | 2,452 | 62.35 | 78 |
| 28,344 | 104,221 | 48.00 | 16.70 | 108,781 | 64.80 | 5,961 |
| 18,184 | 26,417 | 51.60 | 17.95 | 29,637 | 69.65 | 2,569 |
| 52,655 | 74,388 | 52.00 | 18.09 | 84,104 | 70.19 | 5,323 |
| 31,931 | 18,023 | 56.00 | 19.48 | 21,944 | 75.58 | 1,344 |
| 3,200 | 7,000 | 56.40 | 19.62 | 8,584 | 76.13 | 601 |
| 15,125 | 11,942 | 57.00 | 19.83 | 14,801 | 76.94 | 1,433 |
| 5,200 | 5,600 | 58.36 | 20.30 | 7,105 | 78.76 | 179 |
| 618,926 | 1,742,502 | 60.00 | 20.87 | 2,272,876 | 80.98 | 186,528 |
| 139,285 | 377,167 | 61.84 | 21.51 | 507,054 | 83.46 | 40,564 |
| 5,775 | 15,982 | 62.00 | 21.57 | 21,546 | 83.69 | 1,293 |
| 68,858 | 1,676,761 | 64.00 | 22.27 | 2,333,842 | 86.41 | 17,482 |
| 6,435 | 11,155 | 65.80 | 22.89 | 15,958 | 88.81 | 1,277 |
| 16,275 | 474,084 | 67.00 | 23.31 | 690,681 | 90.44 | 55,254 |
| 96,157 | 305,470 | 67.08 | 23.34 | 445,593 | 90.56 | 37,875 |
| 66,969 | 178,605 | 71.00 | 24.70 | 275,722 | 95.84 | 25,918 |
| 632,191 | 459,922 | 71.40 | 24.84 | 714,029 | 96.38 | 65,603 |
| 4,477 | 9,339 | 72.00 | 25.05 | 14,621 | 97.19 | 514 |
| 150,165 | 3,048,510 | 78.00 | 27.14 | 5,183,535 | 105.30 | 53,226 |
| 44,072 | 80,008 | 80.00 | 27.83 | 139,164 | 107.98 | 10,270 |
| 3,856,429 | 54,065,541 | ........ | ....... | 20,993,863 | ........... | 1,128,176 |

The following table gives the production of ammonia, the liquor being reduced to its equivalent in $NH_3$, by States, certain States being combined in order to avoid disclosing individual returns:

### *Production of ammonia in 1905 and 1907, by States.*

### 1905.

| State. | Coal carbonized. | Anhydrous ammonia ($NH_3$), or its equivalent. |
|---|---|---|
| | *Short tons.* | *Pounds.* |
| Alabama and Georgia | 559,837 | 230,207 |
| Colorado and Washington | 58,238 | 243,756 |
| Connecticut and Rhode Island | 55,906 | 262,786 |
| Delaware, Maryland, and District of Columbia | 540,375 | 2,234,627 |
| Illinois | 123,372 | 312,926 |
| Indiana | 84,948 | 33,769 |
| Kentucky | 69,243 | 310,934 |
| Maine and New Hampshire | 26,967 | 69,586 |
| Massachusetts | 856,823 | 774,715 |
| Michigan | 556,621 | 2,654,323 |
| Minnesota | 179,073 | 771,900 |
| Missouri | 166,646 | 784,433 |
| New Jersey | 239,582 | 1,165,550 |
| New York | 626,036 | 2,787,317 |
| Ohio | 604,613 | 1,117,271 |
| Pennsylvania | 1,861,203 | 5,880,172 |
| Tennessee | 58,710 | 91,794 |
| Virginia and West Virginia | 176,398 | 1,002,058 |
| Wisconsin | 350,229 | 1,727,733 |
| Total | [a] 7,194,910 | 22,455,857 |
| Quantity of ammonium sulphate produced and sold (pounds) | 38,663,682 | |

### 1907.

| State. | Coal carbonized. | Anhydrous ammonia ($NH_3$), or its equivalent. |
|---|---|---|
| Alabama and Georgia | 731,228 | 1,064,567 |
| Colorado, Utah, and Washington | 88,967 | 94,373 |
| Connecticut and Rhode Island | 103,268 | 386,074 |
| District of Columbia, Maryland,[b] Virginia, and West Virginia | 745,416 | 1,611,718 |
| Illinois | 662,796 | 1,320,429 |
| Indiana, Iowa, and Missouri | 243,157 | 889,255 |
| Kentucky and Tennessee | 127,504 | 443,222 |
| Maine, New Hampshire, and Vermont | 32,395 | 162,647 |
| Massachusetts | 917,119 | 1,282,664 |
| Michigan | 641,118 | 2,897,898 |
| Minnesota and North Dakota | 194,541 | 642,517 |
| New Jersey | 402,328 | 1,793,009 |
| New York | 1,371,191 | 2,985,854 |
| Ohio | 677,671 | 7,275,883 |
| Pennsylvania | 2,866,065 | 11,594,678 |
| Wisconsin | 656,863 | 3,116,070 |
| Total | 10,461,646 | 37,560,858 |
| Quantity of ammonium sulphate produced and sold (pounds) | 48,882,237 | |

[a] Includes 896,127 tons of coal carbonized at works which made ammonium sulphate.
[b] Production of Maryland reported as ammonium sulphate.

In the following table the total ammonia production has been reduced to its equivalent in $NH_3$ and sulphate:

### *Production of ammonia at gas and by-product coke works of the United States in 1905 and 1907.*

| | 1905. | 1907. |
|---|---|---|
| Coal carbonized .......... short tons | 7,194,910 | 10,461,646 |
| Anhydrous ammonia ($NH_3$), or its equivalent, produced and sold .......... pounds | 22,455,857 | 37,560,858 |
| Equivalent to ammonium sulphate .......... do | 87,128,725 | 145,736,129 |
| Ammonia produced and sold as sulphate .......... do | 38,663,682 | 48,882,237 |
| Value received for anhydrous ammonia ($NH_3$), or its equivalent | $1,728,254 | $2,601,057 |
| Value received for ammonium sulphate | 997,452 | 1,525,472 |
| Total value received | 2,725,706 | 4,126,529 |

## AGGREGATE PRODUCTION AND VALUE.

In the following tables are given the quantity and value of the gas, tar, coke, and ammonia produced in the United States in 1905 and 1907, by States. The aggregate value of this production in 1907 was $73,573,004, as against $56,684,972 in 1905, $51,157,736 in 1904, $47,830,600 in 1903, and $43,869,440 in 1902.

*Production of coal gas and by-products in the United States in 1905 and 1907, by States.*

1905.

| State. | Coal gas produced and used for illuminating and fuel purposes. | By-products. | | | Gas unaccounted for. |
|---|---|---|---|---|---|
| | | Tar. | Anhydrous ammonia, $NH_3$. | Coke. | |
| | *Cubic feet.* | *Gallons.* | *Pounds.* | *Short tons.* | *Cubic feet.* |
| Alabama | 1,905,498,180 | 4,592,516 | 230,207 | 384,206 | 53,281,600 |
| Georgia | 468,572,850 | 712,799 | | 34,720 | 12,075,750 |
| Arkansas | 51,914,400 | 66,900 | ............ | 8,894 | 1,500,000 |
| California | 30,474,033 | 27,220 | ............ | 1,710 | 160,095 |
| Colorado | 496,695,079 | 698,527 | 243,756 | 35,089 | 37,907,421 |
| Washington | 359,180,276 | 465,380 | | 28,006 | 36,460,784 |
| Connecticut | 527,103,580 | 712,328 | 262,786 | 37,958 | 42,679,300 |
| Rhode Island | 490,466,400 | 710,069 | | 34,868 | 45,825,100 |
| Delaware | 60,690,000 | 76,606 | 2,234,627 | 4,128 | 8,867,200 |
| District of Columbia and Maryland | 1,753,770,009 | 4,155,460 | | 406,764 | 44,928,666 |
| Florida, Louisiana, and Mississippi | 67,703,000 | 87,226 | ............ | 6,180 | 15,002,000 |
| Idaho, North Dakota, South Dakota, Utah, and Wyoming | 108,204,812 | 85,458 | ............ | 7,462 | 27,334,824 |
| Illinois | 1,768,186,332 | 2,415,023 | 312,926 | 129,564 | 202,423,328 |
| Indiana | 1,216,172,974 | 1,712,397 | 33,769 | 90,927 | 117,532,469 |
| Indian Territory and Oklahoma | 52,194,000 | 54,002 | ............ | 3,636 | ............ |
| Iowa | 534,747,650 | 633,598 | ............ | 39,369 | 43,427,850 |
| Kansas | 151,847,400 | 205,690 | ............ | 9,749 | 20,280,600 |
| Kentucky | 596,328,520 | 959,293 | 310,934 | 56,328 | 94,285,827 |
| Maine | 154,068,475 | 212,445 | 69,586 | 10,746 | 22,350,305 |
| New Hampshire<br>Vermont | 190,765,514 | 265,556 | | 14,095 | 22,071,586 |
| Massachusetts | 4,975,461,725 | 10,017,517 | 774.715 | 670,542 | 222,242,311 |
| Michigan | 3,263,603,059 | 5,958,602 | 2,654,323 | 470,718 | 176,990,336 |
| Minnesota | 834,691,210 | 2,111,083 | 771,900 | 134,670 | 48,129,190 |
| Missouri | 1,672,955,701 | 2,486,575 | 784,433 | 124,886 | 169,239,499 |
| Montana, Nevada, and New Mexico | 62,522,700 | 89,226 | ............ | 4,017 | 7,820,650 |
| Nebraska | 65,553,100 | 82,393 | ............ | 4,916 | 9,418,000 |
| New Jersey | 1,483,032,012 | 2,774,725 | 1,165,550 | 191,824 | 88,320,888 |
| New York | 5,004,667,394 | 7,349,569 | 2,787,317 | 423,167 | 476,935,569 |
| North Carolina | 58,848,230 | 74,503 | ............ | 5,373 | 14,910,670 |
| Ohio | 4,728,777,755 | 8,479,198 | 1,117,271 | 497,208 | 575,147,235 |
| Oregon | 18,131,200 | 21,452 | ............ | 1,327 | 585,000 |
| Pennsylvania | 3,910,669,305 | 14,249,781 | 5,880,172 | 1,374,815 | 143,841,319 |
| South Carolina | 116,931,170 | 158,361 | ............ | 11,823 | 16,236,500 |
| Tennessee | 430,175,200 | 721,411 | 91,794 | 39,159 | 93,540,900 |
| Texas | 166,917,672 | 236,341 | ............ | 11,984 | 10,370,118 |
| Virginia | 420,420,478 | 691,530 | 1,002,058 | 32,422 | 93,380,992 |
| West Virginia | 129,935,260 | 1,766,066 | | 119,369 | 33,110,000 |
| Wisconsin | 2,126,338,477 | 3,905,217 | 1,727,733 | 293,759 | 171,978,023 |
| Total | 40,454,215,132 | 80,022,043 | 22,455,857 | 5,751,378 | 3,200,591,906 |
| Ammonium sulphate | ............ | ............ | 38,663,682 | ............ | ............ |

*Production of coal gas and by-products in the United States in 1905 and 1907, by States*—Continued.

### 1907.

| State. | Coal gas produced and used for illuminating and fuel purposes. | By-products. | | | Gas unaccounted for. |
|---|---|---|---|---|---|
| | | Tar. | Anhydrous ammonia, $NH_3$. | Coke. | |
| | *Cubic feet.* | *Gallons.* | *Pounds.* | *Short tons.* | *Cubic feet.* |
| Alabama | 1,921,971,552 | 5,898,064 | 1,064,567 | 486,603 | 41,634,118 |
| Georgia | 568,521,991 | 635,889 | | 41,776 | 31,916,916 |
| Arkansas | 47,605,310 | 71,700 | .......... | 3,962 | 5,411,370 |
| California | 15,413,295 | .......... | .......... | .......... | 584,947 |
| Oregon | | 19,421 | .......... | 911 | |
| Colorado | 644,841,746 | 861,799 | 94,373 | 48,552 | 93,713,954 |
| Washington | 515,367,702 | 634,491 | | 36,507 | 83,499,798 |
| Utah | 89,922,944 | 120,925 | | 5,678 | 26,471,956 |
| Nevada | | | .......... | | |
| New Mexico | | | .......... | | |
| Connecticut | 638,553,928 | 886,359 | 386,074 | 42,583 | 40,550,064 |
| Rhode Island | 530,362,495 | 644,026 | | 43,096 | 24,632,705 |
| Delaware | 1,688,622,386 | 4,208,105 | .......... | 364,477 | 51,950,514 |
| District of Columbia | | | 1,611,718 | | |
| Maryland [a] | | | | | |
| Virginia | 519,994,896 | 3,094,593 | | 202,805 | 101,246,773 |
| West Virginia | 569,795,500 | | | | .......... |
| Florida, Louisiana, and Mississippi | 83,326,500 | 95,870 | .......... | 6,483 | 5,930,300 |
| South Dakota | 178,684,330 | .......... | .......... | 9,863 | 14,456,570 |
| Montana | | 144,411 | .......... | | |
| Idaho | | | .......... | | |
| Wyoming | | | .......... | | |
| North Dakota | | | 642,517 | | |
| Minnesota | 1,165,112,873 | 2,388,283 | | 135,967 | 50,863,178 |
| Illinois | 3,512,851,270 | 6,383,125 | 1,320,429 | 521,396 | 219,504,401 |
| Indiana | 1,157,625,728 | 1,498,434 | 889,255 | 84,181 | 98,946,772 |
| Iowa | 624,817,682 | 759,317 | | 39,432 | 49,321,498 |
| Missouri | 1,587,605,454 | 3,870,388 | | 114,748 | 149,043,080 |
| Kansas and Nebraska | 120,974,307 | 113,522 | .......... | 4,774 | 17,042,489 |
| Kentucky | 801,207,172 | 976,622 | 443,222 | 65,087 | 99,724,351 |
| Tennessee | 493,779,463 | 754,135 | | 40,043 | 94,466,200 |
| Maine | 185,616,523 | 295,034 | 162,647 | 10,385 | 19,478,727 |
| New Hampshire and Vermont | 189,388,947 | 235,324 | | 12,521 | 16,100,000 |
| Massachusetts | 5,681,114,554 | 10,650,792 | 1,282,664 | 698,049 | 199,330,381 |
| Michigan | 4,143,702,439 | 8,038,584 | 2,897,898 | 527,276 | 278,004,475 |
| New Jersey | 2,132,580,384 | 3,973,251 | 1,793,009 | 307,844 | 35,470,316 |
| New York | 7,741,442,544 | 13,769,436 | 2,985,854 | 978,057 | 525,700,416 |
| North Carolina and South Carolina | 233,553,043 | 291,871 | .......... | 16,872 | 41,966,758 |
| Ohio | 4,520,575,146 | 8,095,305 | 7,275,883 | 529,650 | 711,554,286 |
| Oklahoma | 99,314,800 | 193,531 | .......... | 2,411 | 6,318,600 |
| Pennsylvania | 9,297,015,239 | 18,304,661 | 11,594,678 | 2,165,066 | 154,513,411 |
| Texas | 221,167,220 | 225,394 | .......... | 12,049 | 30,066,180 |
| Wisconsin | 2,897,255,462 | 5,436,098 | 3,116,070 | 534,040 | 153,444,073 |
| Total | 54,819,684,825 | 103,577,760 | 37,560,858 | 8,093,144 | 3,422,859,577 |
| Ammonium sulphate | .......... | .......... | 48,882,237 | .......... | .......... |

[a] Production of Maryland reported as ammonium sulphate.

*Value of coal gas and by-products produced in the United States in 1905 and 1907, by States.*

### 1905.

| State. | Total value of illuminating and fuel coal gas. | Value of by-products. | | | | Total value of all products. |
|---|---|---|---|---|---|---|
| | | Tar. | Anhydrous ammonia, $NH_3$ (or its equivalent) and ammonium sulphate. | Coke. | Total. | |
| Alabama | $429,817 | $128,271 | $253,453 | $1,157,987 | $1,665,496 | $2,586,451 |
| Georgia | 491,138 | 24,604 | | 101,181 | | |
| Arkansas | 72,026 | 3,677 | ........... | 16,247 | 19,924 | 91,950 |
| California | 47,793 | 2,212 | ........... | 16,384 | 18,596 | 66,389 |
| Colorado | 556,917 | 26,758 | 9,289 | 140,673 | 318,020 | 1,334,040 |
| Washington | 459,103 | 32,268 | | 109,032 | | |
| Connecticut | 579,553 | 35,980 | 8,868 | 133,407 | 333,673 | 1,461,859 |
| Rhode Island | 548,633 | 20,400 | | 135,018 | | |
| Delaware | 61,226 | 2,725 | 434,385 | 12,740 | 1,871,628 | 2,529,212 |
| District of Columbia and Maryland | 596,358 | 87,512 | | 1,334,266 | | |
| Florida, Louisiana, and Mississippi | 90,989 | 5,710 | ........... | 26,313 | 32,023 | 123,012 |
| Idaho, North and South Dakota, Utah, Wyoming | 166,705 | 6,830 | ........... | 42,923 | 49,753 | 216,458 |
| Illinois | 1,912,868 | 49,714 | 22,956 | 487,772 | 560,442 | 2,473,310 |
| Indiana | 1,169,947 | 44,198 | 22,630 | 303,354 | 370,182 | 1,540,129 |
| Indian Territory and Oklahoma | 55,792 | 3,323 | ........... | 16,551 | 19,874 | 75,666 |
| Iowa | 633,557 | 14,775 | ........... | 179,533 | 194,308 | 827,865 |
| Kansas | 194,310 | 10,898 | ........... | 35,260 | 46,158 | 240,468 |
| Kentucky | 539,724 | 17,942 | 15,495 | 183,100 | 216,537 | 756,261 |
| Maine | 212,257 | 9,983 | 3,578 | 51,253 | 152,854 | 620,651 |
| New Hampshire and Vermont | 255,540 | 13,177 | | 74,863 | | |
| Massachusetts | 3,574,116 | 285,666 | 377,260 | 2,247,074 | 2,910,000 | 6,484,116 |
| Michigan | 2,325,377 | 116,809 | 271,333 | 1,592,253 | 1,980,395 | 4,305,772 |
| Minnesota | 842,599 | 54,823 | 59,724 | 569,964 | 684,511 | 1,527,110 |
| Missouri | 1,556,117 | 86,515 | 56,597 | 439,920 | 583,032 | 2,139,149 |
| Montana, Nevada, New Mexico | 114,953 | 3,496 | ........... | 26,348 | 29,844 | 144,797 |
| Nebraska | 83,563 | 2,426 | ........... | 26,135 | 28,561 | 112,124 |
| New Jersey | 1,585,683 | 84,243 | 96,752 | 643,984 | 824,979 | 2,410,662 |
| New York | 5,090,057 | 189,866 | 171,946 | 1,335,345 | 1,697,157 | 6,787,214 |
| North Carolina | 86,011 | 4,355 | ........... | 29,253 | 33,608 | 119,619 |
| Ohio | 3,280,672 | 270,325 | 88,243 | 1,446,387 | 1,804,955 | 5,085,627 |
| Oregon | 39,675 | 2,145 | ........... | 8,946 | 11,091 | 50,766 |
| Pennsylvania | 2,268,505 | 319,201 | 620,068 | 3,903,634 | 4,842,903 | 7,111,408 |
| South Carolina | 159,709 | 5,315 | ........... | 42,992 | 48,307 | 208,016 |
| Tennessee | 434,718 | 29,663 | 5,135 | 135,790 | 170,588 | 605,306 |
| Texas | 253,566 | 15,140 | ........... | 54,531 | 69,671 | 323,237 |
| Virginia | 485,368 | 21,152 | 86,530 | 116,879 | 690,571 | 1,278,794 |
| West Virginia | 102,855 | 50,542 | | 415,468 | | |
| Wisconsin | 1,579,659 | 94,305 | 121,464 | 1,252,106 | 1,467,875 | 3,047,534 |
| Total | 32,937,456 | 2,176,944 | 2,725,706 | 18,844,866 | 23,747,516 | 56,684,972 |

*Value of coal gas and by-products produced in the United States in 1905 and 1907, by States*—Continued.

## 1907.

| State. | Total value of illuminating and fuel coal gas. | Value of by-products. | | | | Total value of all products. |
|---|---|---|---|---|---|---|
| | | Tar. | Anhydrous ammonia, $NH_3$ (or its equivalent) and ammonium sulphate. | Coke. | Total. | |
| Alabama | $495,128 | $177,879 | $403,580 | $1,482,717 | $2,225,260 | $3,332,645 |
| Georgia | 612,257 | 18,738 | | 142,346 | | |
| Arkansas | 63,090 | 3,771 | .......... | 18,152 | 21,923 | 85,013 |
| California | 32,174 | .......... | .......... | .......... | .......... | 40,239 |
| Oregon | | 1,998 | .......... | 6,067 | 8,065 | |
| Colorado | 636,734 | 40,700 | 3,247 | 183,705 | 510,819 | 1,938,602 |
| Washington | 674,994 | 44,804 | | 199,179 | | |
| Utah | 116,055 | 7,431 | | 31,753 | | |
| Nevada | | | .......... | | | |
| New Mexico | | | .......... | | | |
| Connecticut | 659,887 | 32,114 | 20,203 | 154,792 | 377,358 | 1,544,590 |
| Rhode Island | 507,345 | 17,536 | | 152,713 | | |
| Delaware | 633,963 | 86,445 | .......... | 1,558,085 | 2,687,166 | 4,044,079 |
| District of Columbia | | | 348,557 | | | |
| Maryland | | | | | | |
| Virginia | 579,084 | 93,558 | | 600,521 | | |
| West Virginia | 143,866 | | | | | |
| Florida, Louisiana, and Mississippi | 119,303 | 3,955 | .......... | 26,497 | 30,452 | 149,755 |
| South Dakota | 275,116 | .......... | .......... | 72,692 | 738,444 | 1,879,599 |
| Montana | | 9,831 | .......... | | | |
| Idaho | | | .......... | | | |
| Wyoming | | | .......... | | | |
| North Dakota | | | 53,673 | | | |
| Minnesota | 866,039 | 70,082 | | 532,166 | | |
| Illinois | 2,507,850 | 125,049 | 237,459 | 2,339,702 | 2,702,210 | 5,210,060 |
| Indiana | 1,123,481 | 36,049 | 70,045 | 276,154 | 1,106,976 | 4,374,998 |
| Iowa | 701,943 | 18,906 | | 193,804 | | |
| Missouri | 1,442,598 | 90,452 | | 421,566 | | |
| Kansas and Nebraska | 158,756 | 4,082 | .......... | 23,893 | 27,975 | 186,731 |
| Kentucky | 697,961 | 22,577 | 24,344 | 169,591 | 369,538 | 1,562,887 |
| Tennessee | 495,388 | 27,233 | | 125,793 | | |
| Maine | 245,541 | 11,349 | 5,025 | 46,058 | 143,531 | 636,211 |
| New Hampshire and Vermont | 247,139 | 11,388 | | 69,711 | | |
| Massachusetts | 3,887,038 | 299,219 | 435,373 | 2,404,522 | 3,139,114 | 7,026,152 |
| Michigan | 3,061,788 | 173,599 | 272,732 | 2,076,151 | 2,522,482 | 5,584,270 |
| New Jersey | 1,393,827 | 121,049 | 150,389 | 915,169 | 1,186,607 | 2,580,434 |
| New York | 5,215,345 | 302,290 | 639,675 | 3,859,398 | 4,801,363 | 10,016,708 |
| North Carolina and South Carolina | 311,016 | 11,792 | .......... | 75,021 | 86,813 | 397,829 |
| Ohio | 3,266,243 | 218,986 | 185,514 | 1,222,842 | 1,627,342 | 4,893,585 |
| Oklahoma | 112,423 | 14,275 | .......... | 11,296 | 25,571 | 137,994 |
| Pennsylvania | 3,055,816 | 412,127 | 1,011,150 | 8,311,285 | 9,734,562 | 12,790,378 |
| Texas | 312,792 | 12,707 | .......... | 56,407 | 69,114 | 381,906 |
| Wisconsin | 1,810,324 | 129,556 | 265,563 | 2,572,896 | 2,968,015 | 4,778,339 |
| Total | 36,462,304 | 2,651,527 | 4,126,529 | 30,332,644 | 37,110,700 | 73,573,004 |

## IMPORTS OF COAL-TAR PRODUCTS.

As possessing some interest in connection with the statistics of coal-tar production, the following table prepared from figures furnished by the Bureau of Statistics of the Department of Commerce and Labor is presented. Notwithstanding the fact that the United States is now producing coal tar to the extent, as shown in previous tables, of 100,000,000 gallons annually, little progress in the manufacture of chemical products from coal tar as a raw material has been made, and this country depends almost entirely upon Europe (principally Germany) for the chemical products of coal tar. As shown in the following table, this country is importing millions of dollars worth of aniline colors and salts, coal-tar medicinal products, etc. In 1907 the coal tar produced in the United States was worth at first hands $2,651,527, while the coal-tar products imported were valued at $8,846,401, upon which the duty paid was $1,931,904, making the total cost, exclusive of freight and other expenses, jobbers' profits, etc., $10,778,305. In 1906 the coal-tar products imported were valued at $8,536,243, upon which the duty was $1,889,185, and in 1905 the products were valued at $8,344,994, with $1,856,607 of duty. A conservative estimate would place the value of these imports in the wholesale markets of this country at between $12,000,000 and $15,000,000 in each of the last three years. The domestic manufacture of coal tar is restricted almost entirely to the production of creosote oils and of tars and pitches used in the manufacture of roofing paper and for paving materials.

*Coal-tar products imported into the United States, 1898–1907.*

| Year. | Salicylic acid. | | Alizarine and colors or dyes, natural and artificial. | | Aniline salts. | | Coal-tar colors or dyes, not specially provided for. | |
|---|---|---|---|---|---|---|---|---|
| | Value. | Duty. | Value. | Duty. | Value. | Duty. | Value. | Duty. |
| 1898 [a] | $28,688 | $6,794 | $886,349 | Free. | $1,087,704 | Free. | $3,723,288 | $1,098,532 |
| 1899 [a] | 57,192 | 18,536 | 700,786 | Free. | 743,130 | Free. | 3,900,099 | 1,170,030 |
| 1900 [a] | 89,175 | 24,069 | 771,336 | Free. | 537,812 | Free. | 4,792,103 | 1,437,631 |
| 1901 | 76,786 | 22,227 | 713,392 | Free. | 589,535 | Free. | 4,034,171 | 1,210,251 |
| 1902 | 57,852 | 21,913 | 1,028,327 | Free. | 631,467 | Free. | 4,911,668 | 1,473,500 |
| 1903 | 19,012 | 7,827 | 660,464 | Free. | 789,553 | Free. | 5,252,611 | 1,575,783 |
| 1904 | 7,305 | 3,276 | 636,418 | Free. | 686,184 | Free. | 4,903,077 | 1,470,923 |
| 1905 | 2,214 | 923 | 625,491 | Free. | 789,052 | Free. | 5,673,242 | 1,701,973 |
| 1906 | 2,772 | 991 | 661,155 | Free. | 806,901 | Free. | 5,717,932 | 1,715,380 |
| 1907 | 1,240 | 489 | 782,368 | Free. | 667,758 | Free. | 5,830,651 | 1,749,196 |

| Year. | Coal tar, all preparations, not colors or dyes. | | Coal-tar products, not medicinal, not dyes, known as benzol, tuluol, etc. | | Total. | |
|---|---|---|---|---|---|---|
| | Value. | Duty. | Value. | Duty. | Value. | Duty. |
| 1898 [a] | $134,416 | $26,883 | $228,037 | Free. | $6,088,482 | $1,132,209 |
| 1899 [a] | 221,101 | 44,220 | 393,602 | Free. | 6,015,910 | 1,232,786 |
| 1900 [a] | 274,946 | 54,989 | 397,780 | Free. | 6,863,152 | 1,516,689 |
| 1901 | 342,116 | 68,423 | 383,559 | Free. | 6,139,559 | 1,300,901 |
| 1902 | 496,928 | 99,386 | 368,098 | Free. | 7,494,340 | 1,594,799 |
| 1903 | 544,176 | 108,835 | 425,069 | Free. | 7,690,885 | 1,692,445 |
| 1904 | 522,242 | 104,448 | 391,645 | Free. | 7,146,871 | 1,578,647 |
| 1905 | 768,556 | 153,711 | 486,439 | Free. | 8,344,994 | 1,856,607 |
| 1906 | 864,067 | 172,814 | 483,416 | Free. | 8,536,243 | 1,889,185 |
| 1907 | 911,096 | 182,219 | 653,288 | Free. | 8,846,401 | 1,931,904 |

[a] Fiscal years to 1900, inclusive.

# NATURAL GAS.

By B. Hill.

## INTRODUCTION.

By David T. Day.

In spite of the drain on the supply of natural gas in the United States for the last fifty years and the consequent exhaustion of the natural-gas resources in many localities in western Pennsylvania, Ohio, and Indiana, the total value of the gas produced in 1907 exceeded the previous records, aggregating $52,866,835. The value in 1890, when the establishment in Ohio, Indiana, and other States of the factories to use this natural fuel was at its height, was $18,792,725, a little over one-third of the value recorded in 1907. Of course the value per thousand cubic feet has increased very greatly during that period, and the quantity of gas produced in 1907 also showed a very definite increase over the output of 1906. Unfortunately, it is only within the last two years that an accurate record has been kept of the total quantity of natural gas consumed, but by comparison of the two years, it is evident that the increase in price during these years was slight. The great increase in consumption of natural gas was due chiefly to the efforts of well-established companies which are engaged in producing the gas and transporting it over exceptionally great distances. This increase is due rather to the profitable investment of local capital in this industry than to any great increase in demand as is shown by the fact that the production of West Virginia was greatly stimulated in order to transport the gas a distance of over 200 miles to such distant points as Cleveland, Ohio, while in Louisiana the enormous gas pressures are allowing much more gas to go to waste than is utilized, although transportation of the gas from Shreveport to New Orleans would be only slightly more expensive than the present transportation from West Virginia to Cleveland.

This waste of natural gas in the Caddo field of Louisiana is the most flagrant instance of the abuse of national wealth yet recorded in this industry.

## PRODUCTION AND CONSUMPTION.

The following tables present the statistics of production and consumption in detail:

The following table gives, by States, the total value of the natural gas produced in the entire country from 1882 to 1907, inclusive:

*Approximate value of natural gas produced in the United States, 1882–1907, by States.*

| State. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. |
|---|---|---|---|---|---|---|---|
| Pennsylvania | $75,000 | $200,000 | $1,100,000 | $4,500,000 | $9,000,000 | $13,749,500 | $19,282,375 |
| New York | | | | 196,000 | 210,000 | 333,000 | 332,500 |
| Ohio | | | | 100,000 | 400,000 | 1,000,000 | 1,500,000 |
| West Virginia | | | | 40,000 | 60,000 | 120,000 | 120,000 |
| Illinois | | | | 1,200 | 4,000 | | |
| Indiana | | | | | 300,000 | 600,000 | 1,320,000 |
| Kansas | | | | | 6,000 | | |
| Missouri | | | | | | | |
| California | | | | | | | |
| Kentucky and Tennessee | | | | | | | |
| Texas and Alabama | | | | | | | |
| Arkansas and Wyoming | | | | | | | |
| Utah | | | | | | | |
| Colorado | | | | | | | |
| South Dakota | | | | | | | |
| Indian Territory and Oklahoma | | | | | | | |
| Louisiana | | | | | | | |
| Other | 140,000 | 275,000 | 360,000 | 20,000 | 32,000 | 15,000 | 75,000 |
| Total | 215,000 | 475,000 | 1,460,000 | 4,857,200 | 10,012,000 | 15,817,500 | 22,629,875 |

| State. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. |
|---|---|---|---|---|---|---|
| Pennsylvania | $11,593,989 | $9,551,025 | $7,834,016 | $7,376,281 | $6,488,000 | $6,279,000 |
| New York | 530,026 | 552,000 | 280,000 | 216,000 | 210,000 | 249,000 |
| Ohio | 5,215,669 | 4,684,300 | 3,076,325 | 2,136,000 | 1,510,000 | 1,276,100 |
| West Virginia | 12,000 | 5,400 | 35,000 | 70,500 | 123,000 | 395,000 |
| Illinois | 10,615 | 6,000 | 6,000 | 12,988 | 14,000 | 15,000 |
| Indiana | 2,075,702 | 2,302,500 | 3,942,500 | 4,716,000 | 5,718,000 | 5,437,000 |
| Kansas | 15,873 | 12,000 | 5,500 | 40,795 | 50,000 | 86,600 |
| Missouri | 35,687 | 10,500 | 1,500 | 3,775 | 2,100 | 4,500 |
| California | 12,680 | 33,000 | 30,000 | 55,000 | 62,000 | 60,350 |
| Kentucky and Tennessee | 2,580 | 30,000 | 38,993 | 43,175 | 68,500 | 89,200 |
| Texas and Alabama | 1,728 | | | 100 | 50 | 50 |
| Arkansas and Wyoming | 375 | | 250 | 100 | 100 | 100 |
| Utah | | | | | 500 | 500 |
| Colorado | | | | | | 12,000 |
| South Dakota | | | | | | |
| Indian Territory and Oklahoma | | | | | | |
| Louisiana | | | | | | |
| Other | 1,600,175 | 1,606,000 | 250,000 | 200,000 | 100,000 | 50,000 |
| Total | 21,107,099 | 18,792,725 | 15,500,084 | 14,870,714 | 14,346,250 | 13,954,400 |

*Approximate value of natural gas produced in the United States, 1882–1907, by States*—Continued.

| State. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|
| Pennsylvania | $5,852,000 | $5,528,610 | $6,242,543 | $6,806,742 | $8,337,210 | $10,215,412 |
| New York | 241,530 | 256,000 | 200,076 | 229,078 | 294,593 | 335,367 |
| Ohio | 1,255,700 | 1,172,400 | 1,171,777 | 1,488,308 | 1,866,271 | 2,178,234 |
| West Virginia | 100,000 | 640,000 | 912,528 | 1,334,023 | 2,335,864 | 2,959,032 |
| Illinois | 7,500 | 6,375 | 5,000 | 2,498 | 2,067 | 1,700 |
| Indiana | 5,203,200 | 5,043,635 | 5,009,208 | 5,060,969 | 6,680,370 | 7,254,539 |
| Kansas | 112,400 | 124,750 | 105,700 | 174,640 | 332,592 | 356,900 |
| Missouri | 3,500 | 1,500 | 500 | 145 | 290 | 547 |
| California | 55,000 | 55,682 | 50,000 | 65,337 | 86,891 | 79,083 |
| Kentucky and Tennessee | 98,700 | 99,000 | 90,000 | 103,133 | 125,745 | 286,243 |
| Texas and Alabama | 20 | ........ | ........ | 765 | 8,000 | 20,000 |
| Arkansas and Wyoming | 100 | 60 | 40 | ........ | ........ | ........ |
| Utah | 20,000 | 20,000 | 15,050 | 7,875 | ........ | ........ |
| Colorado | 7,000 | 4,500 | 4,000 | 3,300 | 1,480 | 1,800 |
| South Dakota | ........ | ........ | ........ | ........ | 3,500 | 9,817 |
| Indian Territory and Oklahoma | ........ | ........ | ........ | ........ | ........ | ........ |
| Louisiana | ........ | ........ | ........ | ........ | ........ | ........ |
| Other | 50,000 | 50,000 | 20,000 | 20,000 | ........ | ........ |
| Total | 13,006,650 | 13,002,512 | 13,826,422 | 15,296,813 | 20,074,873 | 23,698,674 |

| State. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|---|
| Pennsylvania | $12,688,161 | $14,352,183 | $16,182,834 | $18,139,914 | $19,197,336 | $18,558,245 | $18,844,156 |
| New York | 293,232 | 346,471 | 493,686 | 522,575 | 623,251 | 672,795 | 766,157 |
| Ohio | 2,147,215 | 2,355,458 | 4,479,040 | 5,315,564 | 5,721,462 | 7,145,809 | 8,718,562 |
| West Virginia | 3,954,472 | 5,390,181 | 6,882,359 | 8,114,249 | 10,075,804 | 13,735,343 | 16,670,962 |
| Illinois | 1,825 | 1,844 | 3,310 | 4,745 | 7,223 | 87,211 | 143,577 |
| Indiana | 6,954,566 | 7,081,344 | 6,098,364 | 4,342,409 | 3,094,134 | 1,750,715 | 1,572,605 |
| Kansas | 659,173 | 824,431 | 1,123,849 | 1,517,643 | 2,261,836 | 4,010,986 | 4,843,019 |
| Missouri | 1,328 | 2,154 | 7,070 | 6,285 | 7,390 | 7,210 | 17,010 |
| California | 67,602 | 120,648 | 104,521 | 114,195 | 133,696 | 134,560 | 168,397 |
| Alabama | ........ | ........ | ........ | 14,082 |  | 150,695 |  |
| Texas | 18,577 | 14,953 | 13,851 |  | 14,409 |  | 178,276 |
| Louisiana | ........ | ........ | ........ | ........ | 1,500 |  |  |
| Kentucky | 270,871 | 365,356 | 390,301 | 322,104 | 237,290 | 287,501 | 380,176 |
| Tennessee | ........ | 300 | 300 | 300 | 300 | 300 | 300 |
| Arkansas and Wyoming | ........ | ........ | 2,460 | 6,515 | 21,135 | 34,500 | 126,582 |
| Colorado | 1,800 | 1,900 | 14,140 | 14,300 | 20,752 | 22,800 |  |
| South Dakota | 7,255 | 10,280 | 10,775 | 12,215 | 15,200 | 15,400 | 19,500 |
| Oklahoma | ........ | 360 | 1,000 | 49,665 | 130,137 | 259,862 | 417,221 |
| North Dakota | ........ | ........ | ........ | ........ | ........ | ........ | 235 |
| Oregon | ........ | ........ | ........ | ........ | ........ | ........ | 100 |
| Total | 27,066,077 | 30,867,863 | 35,807,860 | 38,496,760 | 41,562,855 | 46,873,932 | 52,866,835 |

The following table shows the production and consumption of natural gas in 1906 and 1907, by States:

*Quantity and value of natural gas produced and consumed in the United States in 1906 and 1907, by States.*

### 1906.

| State. | Produced. | | | Consumed. | | |
|---|---|---|---|---|---|---|
| | Quantity, M cubic feet. | Cents per M cu. ft. | Value. | Quantity, M cubic feet. | Cents per M cu. ft. | Value. |
| Pennsylvania | 138,161,385 | 13.4 | $18,558,245 | 162,095,173 | 13.0 | $21,085,077 |
| Ohio | 45,436,020 | 15.7 | 7,145,809 | 74,812,562 | 16.9 | 12,652,520 |
| West Virginia | 119,400.392 | 11.5 | 13,735.343 | 58,455,009 | 6.3 | 3,720,440 |
| Kansas | 69,322,633 | 5.8 | 4,010,986 | 69,468,461 | 5.8 | 4,030,776 |
| Missouri | 33,560 | 21.5 | 7,210 | | | |
| New York | 2,547,769 | 26.4 | 672,795 | 10,182,422 | 26.0 | 2,654,115 |
| Indiana | 7,861,140 | 22.2 | 1,750,715 | 7,861,540 | 22.2 | 1,750,755 |
| Kentucky | 789,154 | 36.4 | 287,501 | 789,154 | 36.4 | 287,501 |
| Oklahoma | 3,520,396 | 7.3 | 259,862 | 3,408,128 | 7.2 | 247,282 |
| California | 153,021 | 87.9 | 134,560 | 153,021 | 87.9 | 134,560 |
| Alabama | 1,038,569 | 14.5 | 150,695 | 1,038,569 | 14.5 | 150,695 |
| Louisiana | | | | | | |
| Texas | | | | | | |
| Illinois | 409,556 | 21.3 | 87,211 | 409,556 | 21.3 | 87,211 |
| Colorado | 23.567 | 96.7 | 22,800 | 23,567 | 96.7 | 22,800 |
| Arkansas | 120,500 | 28.6 | 34,500 | 120,500 | 28.6 | 34,500 |
| Wyoming | | | | | | |
| South Dakota | 22,900 | 67.2 | 15,400 | 22,900 | 67.2 | 15,400 |
| Tennessee | 2,000 | 15.0 | 300 | 2,000 | 15.0 | 300 |
| Total | 388,842,562 | 12.1 | 46,873,932 | 388,842,562 | 12.1 | 46,873,932 |

### 1907.

| | | | | | | |
|---|---|---|---|---|---|---|
| Pennsylvania | 135,516,015 | 13.9 | $18,844,156 | 164,541,179 | 13.9 | $22,917,547 |
| West Virginia | 122,687,236 | 13.6 | 16,670,962 | 54,170,520 | 6.9 | 3,757,977 |
| Ohio | 52,040,996 | 16.8 | 8,718,562 | 82,971,768 | 18.4 | 15,227,780 |
| Kansas | 74,526,300 | 6.5 | 4,843,019 | 74,577,695 | 6.5 | 4,853,298 |
| Indiana | 6,624.204 | 23.7 | 1,572,605 | 6,615.204 | 23.7 | 1,570,605 |
| New York | 3,287,974 | 23.3 | 766,157 | 11,857,754 | 26.1 | 3,098,533 |
| Oklahoma | 4,867,031 | 8.5 | 417,221 | 4,815,636 | 8.5 | 406,942 |
| Kentucky | 1,303,158 | 29.2 | 380,176 | 1,303,158 | 29.2 | 380,176 |
| Alabama | 1,287,734 | 13.8 | 178,276 | 1,287,734 | 13.8 | 178,276 |
| Louisiana | | | | | | |
| Texas | | | | | | |
| California | 230,344 | 73.1 | 168,397 | 230,344 | 73.1 | 168,397 |
| Illinois | 1,154,344 | 12.4 | 143,577 | 1,154,344 | 12.4 | 143,577 |
| Arkansas | 766,988 | 16.5 | 126,582 | 766,988 | 16.5 | 126,582 |
| Colorado | | | | | | |
| Wyoming | | | | | | |
| North Dakota | 940 | 25.0 | 235 | 940 | 25.0 | 235 |
| Missouri | 108,090 | 15.7 | 17,010 | 108.090 | 15.7 | 17,010 |
| Tennessee | 2,000 | 15.0 | 300 | 2,000 | 15.0 | 300 |
| South Dakota | 37,500 | 52.0 | 19,500 | 37,500 | 52.0 | 19,500 |
| Oregon | 400 | 25.0 | 100 | 400 | 25.0 | 100 |
| Total | 404,441,254 | 13.07 | 52,866,835 | 404,441,254 | 13.07 | 52.866,835 |

*Distribution of natural gas consumed in the United States in 1906, by States.*

| State. | Number of producers. | Consumers. | | Gas consumed. | | |
|---|---|---|---|---|---|---|
| | | | | Domestic. | | |
| | | Domestic. | Industrial. | Quantity, M cubic feet. | Cents per M cu. ft. | Value. |
| Pennsylvania | 309 | 273,184 | 3,307 | 41,135,808 | 22.2 | $9,128,837 |
| Ohio | 409 | 310,175 | 3,316 | 33,049,479 | 24.7 | 8,165,567 |
| Kansas | 130 | 79,512 | 995 | 9,576,572 | 17.5 | 1,673,979 |
| Missouri | 19 | | | | | |
| West Virginia | 67 | 51,281 | 913 | 9,619,147 | 15.5 | 1,489,473 |
| New York | 143 | 74,538 | 95 | 8,999,871 | 27.7 | 2,495,040 |
| Indiana | 578 | 47,368 | 156 | 5,049,759 | 27.8 | 1,403,987 |
| Kentucky | 45 | 17,216 | 18 | 679,941 | 40.5 | 275,860 |
| Oklahoma | 50 | 8,391 | 202 | 1,446,879 | 11.8 | 170,774 |
| Alabama | 2 | 1 | 1 | 273,919 | 30.4 | 83,320 |
| Louisiana | 4 | 2,700 | 28 | | | |
| Texas | 5 | 702 | 1 | | | |
| California | 18 | 5,537 | 10 | 122,577 | 97.3 | 119,338 |
| Illinois | 66 | 1,429 | 2 | 359,556 | 22.8 | 82,211 |
| Arkansas | 4 | 1,700 | 4 | 58,500 | 49.1 | 28,711 |
| Wyoming | 3 | 3 | 4 | | | |
| Colorado | 3 | 800 | 11 | 20,500 | 100.0 | 20,500 |
| South Dakota | 13 | 406 | 10 | 12,900 | 88.4 | 11,400 |
| Tennessee | 3 | 1 | 1 | 400 | 25.0 | 100 |
| Total | 1,871 | 874,944 | 9,074 | 110,405,808 | 22.7 | 25,149,097 |

| State. | Gas consumed. | | | | | |
|---|---|---|---|---|---|---|
| | Industrial. | | | Total. | | |
| | Quantity, M cubic feet. | Cents per M cu. ft. | Value. | Quantity, M cubic feet. | Cents per M cu. ft. | Value. |
| Pennsylvania | 120,959,365 | 9.9 | $11,956,240 | 162,095,173 | 13.0 | $21,085,077 |
| Ohio | 41,763,083 | 10.7 | 4,486,953 | 74,812,562 | 16.9 | 12,652,520 |
| Kansas | 59,891,889 | 3.9 | 2,356,797 | 69,468,461 | 5.8 | 4,030,776 |
| Missouri | | | | | | |
| West Virginia | 48,835,862 | 4.6 | 2,230,967 | 58,455,009 | 6.3 | 3,720,440 |
| New York | 1,182,551 | 13.4 | 159,075 | 10,182,422 | 26.0 | 2,654,115 |
| Indiana | 2,811,781 | 12.3 | 346,768 | 7,861,540 | 22.2 | 1,750,755 |
| Kentucky | 109,213 | 10.6 | 11,641 | 789,154 | 36.4 | 287,501 |
| Oklahoma | 1,961,249 | 3.9 | 76,508 | 3,408,128 | 7.2 | 247,282 |
| Alabama | 764,650 | 8.8 | 67,375 | 1,038,569 | 14.5 | 150,695 |
| Louisiana | | | | | | |
| Texas | | | | | | |
| California | 30,444 | 50.0 | 15,222 | 153,021 | 87.9 | 134,560 |
| Illinois | 50,000 | 10.0 | 5,000 | 409,556 | 21.3 | 87,211 |
| Arkansas | 62,000 | 9.3 | 5,789 | 120,500 | 28.6 | 34,500 |
| Wyoming | | | | | | |
| Colorado | 3,067 | 75.0 | 2,300 | 23,567 | 96.7 | 22,800 |
| South Dakota | 10,000 | 40.0 | 4,000 | 22,900 | 67.2 | 15,400 |
| Tennessee | 1,600 | 12.5 | 200 | 2,000 | 15.0 | 300 |
| Total | 278,436,754 | 7.8 | 21,724,835 | 388,842,562 | 12.1 | 46,873,932 |

*Distribution of natural gas consumed in the United States in 1907, by States.*

| State. | Number of producers. | Consumers. | | Gas consumed. | | |
|---|---|---|---|---|---|---|
| | | | | Domestic. | | |
| | | Domestic. | Industrial. | Quantity, M cubic feet. | Cents per M cubic feet. | Value. |
| Pennsylvania | 344 | 295,115 | 3,812 | 44,840,748 | 24.2 | $10,846,922 |
| Ohio | 468 | 380,489 | 5,476 | 41,970,198 | 24.4 | 10,228,979 |
| Kansas [a] | 196 | 146,327 | 1,605 | 16,022,597 | 14.8 | 2,374,761 |
| West Virginia | 105 | 53,807 | 1,000 | 9,807,000 | 16.0 | 1,567,911 |
| New York | 208 | 83,805 | 155 | 10,466,829 | 27.9 | 2,918,817 |
| Indiana | 687 | 46,210 | 218 | 4,480,499 | 28.7 | 1,284,160 |
| Oklahoma | 107 | 11,038 | 277 | 1,262,808 | 19.3 | 244,050 |
| Kentucky | 38 | 19,279 | 239 | 1,028,898 | 31.5 | 324,368 |
| Alabama | 2 | 600 | 4 | 343,261 | 30.7 | 105,272 |
| Louisiana | 5 | 3,000 | 38 | | | |
| Texas | 8 | 1,250 | 6 | | | |
| California | 51 | 6,346 | 37 | 97,245 | 102.2 | 99,376 |
| Illinois | 128 | 2,128 | 61 | 344,304 | 22.7 | 78,284 |
| Arkansas | 6 | 3,899 | 35 | 185,405 | 40.5 | 75,182 |
| Colorado | 8 | 1,091 | 21 | | | |
| Wyoming | 4 | 6 | 3 | | | |
| North Dakota | 3 | 3 | ........ | 940 | 25.0 | 235 |
| Missouri | 26 | 239 | 12 | 41,340 | 25.0 | 10,335 |
| Tennessee | 4 | 1 | 1 | 400 | 25.0 | 100 |
| South Dakota | 13 | 529 | 5 | 22,500 | 53.8 | 12,100 |
| Oregon | 1 | 1 | ........ | 400 | 25.0 | 100 |
| Total | 2,407 | 1,055,181 | 13,005 | 130,915,372 | 23.0 | 30,170,952 |

| State. | Gas consumed. | | | | | |
|---|---|---|---|---|---|---|
| | Industrial. | | | Total. | | |
| | Quantity, M cubic feet. | Cents per M cubic feet. | Value. | Quantity, M cubic feet. | Cents per M cubic feet. | Value. |
| Pennsylvania | 119,700,431 | 10.1 | $12,070,625 | 164,541,179 | 13.9 | $22,917,547 |
| Ohio | 41,001,570 | 12.2 | 4,998,801 | 82,971,768 | 18.4 | 15,227,780 |
| Kansas [a] | 58,555,098 | 4.2 | 2,478,537 | 74,577,695 | 6.5 | 4,853,298 |
| West Virginia | 44,363,520 | 4.9 | 2,190,066 | 54,170,520 | 6.9 | 3,757,977 |
| New York | 1,390,925 | 12.9 | 179,716 | 11,857,754 | 26.1 | 3,098,533 |
| Indiana | 2,134,705 | 13.4 | 286,445 | 6,615,204 | 23.7 | 1,570,605 |
| Oklahoma | 3,552,828 | 4.6 | 162,892 | 4,815,636 | 8.5 | 406,942 |
| Kentucky | 274,260 | 20.3 | 55,808 | 1,303,158 | 29.2 | 380,176 |
| Alabama | 944,473 | 7.7 | 73,004 | 1,287,734 | 13.8 | 178,276 |
| Louisiana | | | | | | |
| Texas | | | | | | |
| California | 133,099 | 51.8 | 69,021 | 230,344 | 73.1 | 168,397 |
| Illinois | 810,040 | 8.1 | 65,293 | 1,154,344 | 12.4 | 143,577 |
| Arkansas | 581,583 | 8.8 | 51,400 | 766,988 | 16.5 | 126,582 |
| Colorado | | | | | | |
| Wyoming | | | | | | |
| North Dakota | ........ | ........ | ........ | [b] 940 | 25.0 | [b] 235 |
| Missouri | 66,750 | 10.0 | 6,675 | 108,090 | 15.7 | 17,010 |
| Tennessee | 1,600 | 12.5 | 200 | 2,000 | 15.0 | 300 |
| South Dakota | 15,000 | 49.3 | 7,400 | 37,500 | 52.0 | 19,500 |
| Oregon | ........ | ........ | ........ | [b] 400 | 25.0 | [b] 100 |
| Total | 273,525,582 | 8.3 | 22,695,883 | 404,441,254 | 13.07 | 52,866,835 |

[a] Includes the consumption of gas piped from Kansas to Missouri.

[b] Estimated.

*Value of natural gas consumed in the United States, 1902–1907, by States.*

| State. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| Pennsylvania | $13,942,783 | $16,060,196 | $17,205,804 | $19,237,218 | $21,085,077 | $22,917,547 |
| Ohio | 4,785,766 | 7,200,867 | 9,393,843 | 10,396,633 | 12,652,520 | 15,227,780 |
| Kansas | 824,431 | 1,123,849 | 1,517,643 | 2,265,945 | 4,030,776 | [b] 4,853,298 |
| Missouri | 2,154 | 7,070 | 6,285 | 7,390 | | 17,010 |
| West Virginia | 2,473,174 | 3,125,061 | 3,383,515 | 3,586,608 | 3,720,440 | 3,757,977 |
| New York | 1,723,709 | 1,944,667 | 2,222,980 | 2,434,894 | 2,654,115 | 3,098,533 |
| Indiana | [a] 6,710,080 | [a] 5,915,367 | [a] 4,282,409 | [a] 3,056,634 | [a] 1,750,755 | 1,570,605 |
| Kentucky | 255,481 | 280,426 | 268,264 | 237,290 | 287,501 | 380,176 |
| Oklahoma | 360 | 1,000 | 49,665 | 126,028 | 247,282 | 406,942 |
| Alabama | .......... | .......... | 14,082 | | 150,695 | |
| Texas | 14,953 | 13,851 | | 14,409 | | 178,276 |
| Louisiana | .......... | .......... | .......... | 1,500 | | |
| California | 120,648 | 104,521 | 114,195 | 133,696 | 134,560 | 168,397 |
| Illinois | 1,844 | 3,310 | 4,745 | 7,223 | 87,211 | 143,577 |
| Arkansas | .......... | 2,460 | 6,515 | 21,135 | 34,500 | 126,582 |
| Wyoming | .......... | | | | | |
| Colorado | 1,900 | 14,140 | 14,300 | 20,752 | 22,800 | |
| South Dakota | 10,280 | 10,775 | 12,215 | 15,200 | 15,400 | 19,500 |
| Tennessee | 300 | 300 | 300 | 300 | 300 | 300 |
| North Dakota | .......... | .......... | .......... | .......... | .......... | 235 |
| Oregon | .......... | .......... | .......... | .......... | .......... | 100 |
| Total | 30,867,863 | 35,807,860 | 38,496,760 | 41,562,855 | 46,873,932 | 52,866,835 |

[a] A portion of this was consumed in Chicago, Ill.
[b] Includes value of gas piped from Kansas to Missouri.

## COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following tables give the value of natural gas and of petroleum and their combined value in 1906 and 1907, by States, arranged in the order of the value of the combined production:

*Value of the natural gas and petroleum produced in 1906 and 1907, and their combined value, by States.*

### 1906.

| State. | Value of natural gas. | Value of crude petroleum. | Value of natural gas and crude petroleum. |
|---|---|---|---|
| Pennsylvania | $18,558,245 | $16,596,943 | $35,155,188 |
| West Virginia | 13,735,343 | 16,170,293 | 29,905,636 |
| Ohio | 7,145,809 | 16,997,000 | 24,142,809 |
| Oklahoma | 259,862 | 9,615,198 | 13,886,046 |
| Kansas | 4,010,986 | | |
| Alabama | 150,695 | 0 | 10,274,111 |
| Louisiana | | 3,557,838 | |
| Texas | | 6,565,578 | |
| California | 134,560 | 9,553,430 | 9,687,990 |
| Indiana | 1,750,715 | 6,770,066 | 8,520,781 |
| Illinois | 87,211 | 3,274,818 | 3,362,029 |
| New York | 672,795 | 1,995,377 | 2,668,172 |
| Kentucky | 287,801 | 1,031,629 | 1,319,430 |
| Tennessee | | | |
| Colorado | 22,800 | 262,675 | 285,475 |
| Arkansas | 34,500 | 49,000 | 83,500 |
| Wyoming | | | |
| South Dakota | 15,400 | 0 | 15,400 |
| Michigan | 0 | 4,890 | 12,100 |
| Missouri | 7,210 | | |
| Total | 46,873,932 | 92,444,735 | 139,318,667 |

*Value of the natural gas and petroleum produced in 1906 and 1907, and their combined value, by States*—Continued.

### 1907.

| State. | Value of natural gas. | Value of crude petroleum. | Value of natural gas and crude petroleum. |
|---|---|---|---|
| Pennsylvania | $18,844,156 | $17,579,706 | $36,423,862 |
| West Virginia | 16,670,962 | 15,852,428 | 32,523,390 |
| Kansas | 4,843,019 | 18,478,658 | 23,738,898 |
| Oklahoma | 417,221 | | |
| Ohio | 8,718,562 | 14,769,888 | 23,488,450 |
| Illinois | 143,577 | 16,432,947 | 16,576,524 |
| California | 168,397 | 14,699,956 | 14,868,353 |
| Alabama | 178,276 | ........ | 14,643,172 |
| Louisiana | | 4,063,033 | |
| Texas | | 10,401,863 | |
| Indiana | 1,572,605 | 4,536,930 | 6,109,535 |
| New York | 766,157 | 2,127,748 | 2,893,905 |
| Kentucky | 380,176 | 862,396 | 1,242,872 |
| Tennessee | 300 | | |
| Arkansas | 126,582 | | 421,278 |
| Colorado | | 272,813 | |
| Wyoming | | 21,883 | |
| Utah | ........ | | |
| Michigan | ........ | 6,500 | 23,510 |
| Missouri | 17,010 | | |
| North Dakota | 19,500 | ........ | 19,500 |
| South Dakota | 235 | ........ | 235 |
| Oregon | 100 | ........ | 100 |
| Total | 52,866,835 | 120,106,749 | 172,973,584 |

## WELL RECORD.

The following table gives the record of natural gas wells in 1907, by States:

*Record of natural gas wells in 1907, by States.*

| State. | Wells. | | | | | |
|---|---|---|---|---|---|---|
| | Productive Dec. 31, 1906. | Drilled in 1907. | | | Abandoned in 1907 | Productive Dec. 31, 1907. |
| | | Gas. | Dry. | Total. | | |
| Alabama | 10 | 3 | 4 | 7 | ........ | 13 |
| Arkansas | 36 | 23 | 2 | 25 | ........ | 59 |
| California | 43 | 2 | ........ | 2 | ........ | 45 |
| Colorado | 3 | ........ | ........ | ........ | ........ | 3 |
| Illinois | 158 | 94 | 41 | 135 | 11 | 241 |
| Indiana | 3,227 | 185 | 56 | 241 | 322 | 3,090 |
| Kansas | 1,495 | 361 | 163 | 524 | 197 | 1,659 |
| Kentucky | 156 | 31 | 14 | 45 | 18 | 169 |
| Louisiana | 20 | 10 | 4 | 14 | ........ | 30 |
| Missouri | [a] 57 | 25 | 6 | 31 | 11 | [a] 71 |
| New York | 919 | 61 | 13 | 74 | 16 | 964 |
| North Dakota | 3 | ........ | ........ | ........ | ........ | 3 |
| Ohio | 1,977 | 431 | 90 | 521 | 118 | 2,290 |
| Oklahoma | 239 | 99 | 41 | 140 | 23 | 315 |
| Oregon | 1 | ........ | ........ | ........ | ........ | 1 |
| Pennsylvania | 7,000 | 769 | 180 | 949 | 248 | 7,521 |
| South Dakota | 20 | 1 | ........ | 1 | ........ | 21 |
| Tennessee | 4 | ........ | ........ | ........ | ........ | 4 |
| Texas | 18 | 8 | 7 | 15 | 3 | 23 |
| West Virginia | 1,831 | 377 | 59 | 436 | 69 | 2,139 |
| Wyoming | 9 | 4 | ........ | 4 | ........ | 13 |
| Total | 17,226 | 2,484 | 680 | 3,164 | 1,036 | 18,674 |

[a] Include some wells which produce both oil and gas.

## ACREAGE CONTROLLED BY NATURAL GAS COMPANIES.

The following table shows the number of acres of land held by natural gas companies in 1906 and 1907 and whether the acreage was owned or leased, and also whether it was held by operation or by rental:

*Acreage controlled by natural gas companies in 1906 and 1907, by States.*

1906.

| State. | Acreage. | | | | |
|---|---|---|---|---|---|
| | Owned. | Leased. | Total. | Held by operation. | Held by rental. |
| Alabama | 70 | 70,000 | 70,070 | 3,000 | 67,000 |
| Arkansas | ........ | 50,320 | 50,320 | 1,920 | 48,400 |
| California | 648 | ........ | 648 | ........ | ........ |
| Colorado | ........ | ........ | ........ | ........ | ........ |
| Illinois | ........ | 34,785 | 34,785 | 2,715 | 32,070 |
| Indiana | 16,539 | 117,785 | 134,324 | 71,570 | 46,215 |
| Kansas | 15,607 | [a] 567,469 | 583,076 | 103,906 | 207,371 |
| Kentucky | 138 | 47,493 | 47,631 | 7,422 | 40,071 |
| Louisiana | ........ | ........ | ........ | ........ | ........ |
| Missouri | 2,068 | 10,015 | 12,083 | 40 | 9,975 |
| New York | 2,331 | 118,305 | 120,636 | 35,578 | 82,727 |
| Ohio | 5,182 | 712,451 | 717,633 | 114,219 | 598,232 |
| Oklahoma | 6,527 | 711,999 | 718,526 | 692,209 | 19,790 |
| Pennsylvania | 322,029 | 1,325,664 | 1,647,693 | 397,286 | 928,378 |
| South Dakota | ........ | ........ | ........ | ........ | ........ |
| Tennessee | ........ | 2,500 | 2,500 | ........ | 2,500 |
| Texas | 598 | 28,709 | 29,307 | 7,720 | 20,989 |
| West Virginia | 34,078 | 1,039,173 | 1,073,251 | 250,856 | 788,317 |
| Wyoming | 250 | 2,210 | 2,460 | 1,490 | 720 |
| Total | 406,065 | [a] 4,838,878 | 5,244,943 | 1,689,931 | 2,892,755 |

1907.

| | | | | | |
|---|---|---|---|---|---|
| Alabama | 70 | 30,000 | 30,070 | ........ | 30,000 |
| Arkansas | 2,100 | 140,148 | 142,248 | 4,880 | 135,268 |
| California | 646 | ........ | 646 | ........ | ........ |
| Colorado | ........ | 4 | 4 | 4 | ........ |
| Illinois | ........ | 47,250 | 47,250 | 7,780 | 39,470 |
| Indiana | 23,547 | 121,161 | 144,708 | 63,658 | 55,513 |
| Kansas | 22,543 | 664,370 | 686,913 | 100,017 | 307,495 |
| Kentucky | 256 | 64,162 | 64,418 | 12,727 | 51,435 |
| Louisiana | 500 | 39,000 | 39,500 | ........ | 39,000 |
| Missouri | 1,491 | 40,535 | 42,026 | 45 | 11,480 |
| New York | 3,238 | 122,575 | 125,813 | 36,881 | 85,694 |
| North Dakota | ........ | ........ | ........ | ........ | ........ |
| Ohio | 11,855 | 849,436 | 861,291 | 146,763 | 668,122 |
| Oklahoma | 7,808 | 742,157 | 749,965 | 703,387 | 38,770 |
| Pennsylvania | 334,454 | 1,419,808 | 1,754,262 | 429,937 | 989,871 |
| South Dakota | ........ | ........ | ........ | ........ | ........ |
| Tennessee | ........ | ........ | ........ | ........ | ........ |
| Texas | ........ | 28,112 | 28,112 | 6,680 | 21,432 |
| West Virginia | 38,126 | 2,039,743 | 2,077,869 | 428,051 | 1,611,692 |
| Wyoming | 250 | 2,390 | 2,640 | 1,670 | 720 |
| Total | 446,884 | [a] 6,350,851 | 6,797,735 | 1,942,480 | 4,085,962 |

[a] Includes 256,192 acres in 1906 and 322,409 acres in 1907, concerning which no statements were made as to whether they were held by operation or by rental.

## NATURAL-GAS INDUSTRY BY STATES.

### PENNSYLVANIA.

The following table shows that the number of domestic and industrial consumers and the quantity and value of the gas consumed in Pennsylvania in 1907 was greater than in any previous year; also that the consumption of gas in this State in 1907 was almost twice as much as the quantity consumed in Ohio, and its value 50 per cent more than that of Ohio, which State is the next largest consumer of gas.

The price of gas for domestic purposes in 1907 ranged from 10 to 33 cents per 1,000 cubic feet, an average of 24.2 cents, which is a slight advance as compared with 1906, when the average price was 22.2 cents per 1,000 cubic feet. The price of gas for industrial purposes ranged from 5 to 20 cents per 1,000 cubic feet, according to the quantity to be used, the average for the year being 10.1 cents, an increase of 1 cent as compared with 1906. The average price per 1,000 cubic feet received for all gas consumed in Pennsylvania in 1907 was 13.9 cents, as compared with 13 cents in 1906.

During 1907 a total of 949 wells were completed in Pennsylvania, of which 769 were producers of gas and 180 were dry. The most important gas well developed in 1907, supposed to be the largest gas well ever drilled in the State, was the Hoge well No. 1 on the Samuel Hoge farm, Center Township, Greene County. The capacity of this well is estimated at from 50,000,000 to 60,000,000 cubic feet per day. It will make about 1,000 pounds pressure in $5\frac{3}{16}$-inch casing. The total depth of the well is about 2,870 feet, gas at 2,860 feet. This well was completed on November 23, 1907, and was not put to use until 1908. Another good gas well, with an estimated production of 18,000,000 cubic feet daily, was drilled late in 1907 about 6 miles from Waynesburg, and will be used by manufacturing interests of Pittsburg.

*Record of natural-gas industry in Pennsylvania, 1897–1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1897 | 176 | $6,242,543 | [a] 201,059 | 1,124 | $5,392,661 | 314 | 96 | 2,467 |
| 1898 | 232 | 6,806,742 | [a] 213,410 | 1,021 | 6,064,477 | 373 | 74 | 2,840 |
| 1899 | 281 | 8,337,210 | [a] 232,000 | 1,236 | 7,926,970 | 467 | 104 | 3,303 |
| 1900 | 266 | 10,215,412 | [a] 229,730 | 1,296 | 9,812,615 | 513 | 142 | 3,776 |
| 1901 | 296 | 12,688,161 | [a] 326,912 | 1,743 | 11,785,906 | 660 | 143 | 4,436 |
| 1902 | 379 | 14,352,183 | 185,678 | 2,448 | 13,942,783 | 775 | 232 | 5,211 |
| 1903 | 414 | 16,182,834 | 214,432 | 2,834 | 16,060,196 | 609 | 126 | 5,910 |
| 1904 | 414 | 18,139,914 | 238,481 | 2,929 | 17,205,804 | 701 | 174 | 6,352 |
| 1905 | 351 | 19,197,336 | 257,416 | 2,845 | 19,237,218 | 765 | 168 | 6,566 |
| 1906 | 309 | 18,558,245 | 273,184 | 3,307 | 21,085,077 | 603 | 153 | 7,000 |
| 1907 | [b] 344 | 18,844,156 | 295,115 | 3,812 | 22,917,547 | 769 | 180 | 7,521 |

[a] Number of fires supplied.

[b] Includes 32 companies producing gas from oil wells only.

*Depth and gas pressure of wells in Pennsylvania in 1906 and 1907, by counties.*

| County. | Depth, in feet. | Pressure in pounds. | |
|---|---|---|---|
| | | 1906. | 1907. |
| Allegheny | 1,530-2,800 | 1- 380 | 7- 400 |
| Armstrong | 800-3,384 | 7- 900 | 6- 800 |
| Beaver | 1,000 | | 4 |
| Butler | 900-2,600 | 22- 700 | 15- 625 |
| Clarion | 600-2,600 | 6- 450 | 3- 700 |
| Elk | 1,400-2,650 | 50- 990 | 49- 960 |
| Crawford | 750- 800 | 25- 100 | 10- 200 |
| Erie | | | |
| Fayette and Somerset | 1,700-2,660 | 28- 300 | 100- 550 |
| Forest | 700-2,600 | 6- 90 | 75- 250 |
| Greene | 1,400-3,200 | 80- 350 | 80-1,200 |
| Jefferson | 1,800-2,715 | 70- 800 | 200- 500 |
| McKean | 1,000-2,600 | 18- 890 | 20- 450 |
| Mercer | 1,100-1,500 | 30- 150 | |
| Potter | 750-2,200 | 125- 400 | 40- 360 |
| Tioga | 730-1,400 | | 350 |
| Venango | 1,000-2,000 | 90- 200 | 70- 150 |
| Warren | 600-1,600 | 20- 100 | 10- 60 |
| Washington | 612-3,304 | 30-1,300 | 15- 100 |
| Westmoreland | 1,800-2,300 | 80- 100 | 25 |

## NEW YORK.

It will be seen from the following table that the total value of gas consumed in New York in 1907 was $3,098,533, and the value of gas produced $766,157, the difference, amounting to $2,332,376 being the value of gas produced in Pennsylvania and piped to this State for consumption. The value of gas produced in New York increased from $672,795, in 1906 to $766,157 in 1907, or $93,362. No new gas developments have been reported in this State in 1907.

The price of gas per 1,000 cubic feet in 1907 ranged from 10 cents for gas used for industrial purposes to $1.10 for gas used for illuminating purposes. The average price received for gas sold for domestic purposes in 1907 was 27.9 cents per 1,000 cubic feet and for industrial purposes 12.9 per 1,000 cubic feet, the average price for all natural gas sold in the State being 26.1 cents per 1,000 cubic feet.

*Record of natural gas industry in New York, 1897–1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1897 | 41 | $200,076 | [a] 55,086 | 80 | $874,617 | 33 | 7 | 359 |
| 1898 | 62 | 229,078 | [a] 68,662 | 103 | 1,006,567 | 63 | 9 | 422 |
| 1899 | 84 | 294,593 | [a] 76,544 | 121 | 1,236,007 | 36 | 7 | 447 |
| 1900 | 89 | 335,367 | [a] 89,837 | 138 | 1,456,286 | 57 | 11 | 504 |
| 1901 | 114 | 293,232 | [a] 95,161 | 98 | 1,694,925 | 53 | 14 | 557 |
| 1902 | 116 | 346,471 | 50,536 | 215 | 1,723,709 | 69 | 8 | 626 |
| 1903 | 144 | 493,686 | 57,935 | 208 | 1,944,667 | 75 | 11 | 700 |
| 1904 | 153 | 522,575 | 67,203 | 451 | 2,222,960 | 78 | 12 | 744 |
| 1905 | 148 | 623,251 | 67,848 | 447 | 2,434,894 | 89 | 17 | 839 |
| 1906 | 143 | 672,795 | 74,538 | 95 | 2,654,115 | 64 | 14 | 919 |
| 1907 | [b] 208 | 766,157 | 83,805 | 155 | 3,098,533 | 61 | 13 | 964 |

[a] Number of fires supplied.

[b] Includes 37 companies which produced gas from oil wells only.

*Depth and gas pressure of wells in New York in 1906 and 1907, by counties.*

| County. | Depth in feet. | Pressure in pounds. | |
|---|---|---|---|
| | | 1906. | 1907. |
| Allegany | 600-1,500 | 30-250 | 10-150 |
| Cattaraugus | 400-2,300 | 20- 90 | 5- 85 |
| Chautauqua | 150-2,471 | 5-650 | 1-800 |
| Erie | 300-2,250 | 56-400 | 40-585 |
| Niagara | 550 | | ........ |
| Genesee | 1,150-1,750 | ........ | 300-580 |
| Livingston | 120-1,150 | 5- 10 | 10 |
| Onondaga | 1,000-3,000 | 100-350 | 100 |
| Ontario | 700-2,200 | 10-600 | 65-425 |
| Seneca | 1,450-1,500 | | |
| Oswego | 800-1,200 | 4-400 | ........ |
| Schuyler | 1,400 | 100-435 | 100-435 |
| Yates | 1,200 | | |
| Steuben | 600-850 | 70-300 | ........ |
| Wyoming | 1,700-1,800 | 120-200 | 140-200 |

## WEST VIRGINIA.

The value of gas consumed in West Virginia increased from $3,720,440 in 1906 to $3,757,977 in 1907, a gain of $37,537. The value of gas produced in this State increased from $13,735,343 in 1906 to $16,670,962 in 1907, or $2,935,619. It must be understood that these figures of quantity and value of gas produced in West Virginia are only approximately correct, as some gas is piped from this State through the same pipe line as gas from another State, and it is impossible to make a separation of the quantity produced in each State. The difference between the value of gas consumed and the value of gas produced gives the value of gas piped from West Virginia to consumers in other States. The increase in the value of gas produced is partly the result of an increased price of the gas for both domestic and manufacturing purposes in 1907 as against 1906. The total value given for the gas produced is the price received for it at the point of consumption. As compared with 1906, it will be noted that the quantity and value of the gas consumed in West Virginia in 1907 for domestic purposes increased, while the quantity and value of gas consumed for industrial purposes declined slightly. As considerable of the gas consumed in West Virginia is sold at flat rates, the quantity of gas consumed can only be given approximately. The price of gas sold for domestic purposes in this State in 1907 ranged from 7 to 25 cents per 1,000 cubic feet, an average of 16 cents, and for industrial purposes from 2½ to 15 cents, an average of 4.9 cents, the total average price in 1907 for the State being 6.9 cents per 1,000 cubic feet.

Gas consumed in West Virginia for industrial purposes is largely used in the manufacture of carbon black. In 1907 it is reported that 11,594,784 thousand cubic feet were consumed, valued at $335,993, as compared with 14,405,043 thousand cubic feet in 1906, valued at $395,002. Gas is also used in this State in the manufacture of iron, brick, and glass.

During 1907 there were 377 gas wells completed in West Virginia, making the number of productive gas wells 2,139 at the close of the year. Millions of feet of gas are produced in this State and await a market, the wells being closed in. During the year a pipe line was laid to convey gas from this State to Cleveland, making the third pipe line from this State to northeastern Ohio. Cumberland, Md., has also been piped for gas, and consumers in that city were supplied in 1907 with gas from the gas fields of West Virginia.

Work is being rushed to bring the supply of natural gas in Cleveland up to a point above the needs of the city before the cold weather of winter sets in. A third crew of men has been put to work on the new pipe line of the East Ohio Gas Company, making a total of more than 1,500 men engaged in the task of laying this 120 miles of 18-inch line from the gas fields of West Virginia to Cleveland. All summer two crews have been engaged in this work, the number of men which could be employed to any advantage being limited by the rapidity of the delivery of material. Of the 120 miles 65 are now laid, and the remaining 55 are being completed at the rate of a mile a day. The line will terminate at the company's pressure regulating station at Richardson's station or Willow. The new line will add 75 per cent to the present natural gas supply of the city. The two lines now in service, one of 18 and one of 12-inch diameter, have a capacity of 48,000,000 cubic feet a day. They supply also a number of smaller towns before reaching Cleveland. The new line will have a capacity of 35,000,000 cubic feet daily, and when it is completed it will be possible for the smaller towns to be served by the 12-inch pipe, while Cleveland gets the full benefit of the two 18-inch lines. The line crosses the Ohio River from West Virginia opposite Clarington, Ohio, at a point between Moundsville and New Martinsville, W. Va. It comes north through Monroe, Belmont, Harrison, Tuscarawas, Stark, and Summit counties to Cuyahoga. The line is costing $2,000,000. The labor cost is large on account of the unusual wages paid for this class of work.

*Record of natural gas industry in West Virginia, 1897–1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1897 | 12 | $912,528 | [a] 30,015 | 393 | $791,192 | 47 | 1 | 196 |
| 1898 | 19 | 1,334,023 | [a] 28,652 | 125 | 914,969 | 32 | 4 | 227 |
| 1899 | 30 | 2,335,864 | [a] 38,137 | 305 | 1,310,675 | 78 | 6 | 300 |
| 1900 | 34 | 2,959,032 | [a] 45,943 | 184 | 1,530,378 | 129 | 6 | 428 |
| 1901 | 44 | 3,954,472 | [a] 55,808 | 266 | 2,244,758 | 177 | 8 | 604 |
| 1902 | 79 | 5,390,181 | 29,357 | 877 | 2,473,174 | 142 | 37 | 745 |
| 1903 | 88 | 6,882,259 | 36,179 | 1,122 | 3,125,061 | 242 | 43 | 987 |
| 1904 | 90 | 8,114,249 | 44,563 | 1,005 | 3,383,515 | 292 | 33 | 1,274 |
| 1905 | 76 | 10,075,804 | 45,588 | 1,417 | 3,586,608 | 385 | 28 | 1,579 |
| 1906 | 67 | 13,735,343 | 51,281 | 913 | 3,720,440 | 263 | 23 | 1,831 |
| 1907 | [b] 105 | 16,670,962 | 53,807 | 1,060 | [c] 3,757,977 | 377 | 59 | [d] 2,139 |

[a] Number of fires supplied.
[b] Includes 10 companies which produced gas from oil wells only.
[c] Includes gas consumed in Maryland.
[d] Includes 34 wells not in use in 1907.

*Depth and gas pressure of wells in West Virginia in 1906 and 1907, by counties.*

| County. | Depth, in feet. | Pressure, in pounds. | |
|---|---|---|---|
| | | 1906. | 1907. |
| Braxton | 1,750-2,300 | ... | 250-900 |
| Clay | | | |
| Taylor | | | |
| Brooke | 1,300-1,700 | ... | 100 |
| Cabell | 900-2,165 | 350- 650 | 300-625 |
| Calhoun | 1,470-4,000 | 300 | 200-600 |
| Doddridge | 1,700-2,921 | 100- 900 | 180-620 |
| Gilmer | 1,280-2,873 | 465 | ... |
| Hancock | 800-1,220 | 80- 90 | 15-300 |
| Harrison | 2,300-3,049 | 325-1,000 | 105-975 |
| Kanawha | 1,500-1,700 | ... | ... |
| Lewis | 1,510-2,700 | 200- 900 | 250-900 |
| Lincoln | 1,200-2,300 | ... | 500 |
| Marion | 2,700-3,000 | 400- 750 | 300-350 |
| Monongalia | 1,400-3,106 | 150- 500 | 140-450 |
| Pleasants | 1,200-1,985 | ... | 50-300 |
| Ritchie | 1,796-2,000 | ... | ... |
| Roane | 1,472-1,900 | ... | 340 |
| Tyler | 1,650-2,700 | 80 | 160-550 |
| Wetzel | 2,344-3,000 | 42- 50 | 125-242 |
| Wirt | 700-1,400 | 60- 530 | 20-530 |

## KENTUCKY.

The value of natural gas consumed in Kentucky in 1907 was $380,176, as compared with $287,501 in 1906, an increase of $92,675. During the past year no new gas fields were discovered, but development work was carried on quite extensively in Menifee County, and a number of new gas wells were completed. This gas field is of considerable magnitude, and the depth of wells ranges from 500 to 800 feet, averaging 700 feet. The Central Kentucky Natural Gas Company extended its line from this gas field to Winchester and Mount Sterling, which, in addition to Lexington, were supplied with gas. The Cumberland Gas Company began business in 1907, piping gas from wells in Knox County to consumers in Barboursville.

## OHIO.

The following table shows an increase in both value of gas produced and value of gas consumed in Ohio in 1907, as compared with previous years, and the probability is that the report for 1908 will show a further increase in consumption of gas in this State, as pipe lines are being extended. Cincinnati, which is now using natural gas, was not supplied until late in 1907. Although Ohio has some exceptional gas wells of large volume and high pressure, their production is not adequate to supply the demands of the State, and consumers are dependent upon the gas fields of Pennsylvania and West Virginia for part of their supply. Referring to the table of production and consumption, it will be seen that while gas valued at $15,227,780 was consumed in this State in 1907 the production was valued at only $8,718,562, the difference, amounting to $6,509,218, being the value of gas piped from outside the State.

During 1907 a total of 431 gas wells were completed in Ohio, making the number of productive gas wells at the close of last year 2,290. In localities where the wells have not been heavily drawn upon the pressure remains about the same as in 1906, but in some districts where the sands are porous and wells are drawn upon by artificial means it is reported that the pressure has been reduced from 700 pounds in 1904 to 200 pounds on January 1, 1908.

An examination of the table referred to shows that about the same quantity of gas was consumed for industrial as for domestic purposes in 1907, but that the average price received for industrial gas was only one-half the price of domestic gas. The rate charged domestic consumers for gas in this State ranged from 10 to 35 cents per 1,000 cubic feet, the average price being 24.4 cents, while the rate charged industrial consumers ranged from 4½ to 35 cents per 1,000 cubic feet, an average of 12.2 cents. The total average price received for all gas was 18.4 cents per 1,000 cubic feet in 1907.

*Record of natural gas industry in Ohio, 1897–1907.*

| Year. | Gas produced. |  | Gas consumed. |  |  | Wells. |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Number of producers. | Value. | Number of consumers. |  | Value. | Drilled. |  | Productive Dec. 31. |
|  |  |  | Domestic. | Industrial. |  | Gas. | Dry. |  |
| 1897 | 157 | $1,171,777 | [a] 85,368 | 183 | $1,506,454 | 88 | 51 | 729 |
| 1898 | 237 | 1,488,308 | [a] 68,211 | 349 | 2,250,706 | 120 | 12 | 806 |
| 1899 | 359 | 1,866,271 | [a] 77,787 | 691 | 3,207,286 | 134 | 17 | 929 |
| 1900 | 281 | 2,178,234 | [a] 135,743 | 1,092 | 3,823,209 | 97 | 19 | 990 |
| 1901 | 305 | 2,147,215 | [a] 149,709 | 949 | 4,119,059 | 113 | 35 | 1,099 |
| 1902 | 451 | 2,355,458 | 120,127 | 786 | 4,785,766 | 266 | 40 | 1,343 |
| 1903 | 515 | 4,479,040 | 197,710 | 1,786 | 7,290,867 | 290 | 62 | 1,523 |
| 1904 | 453 | 5,315,564 | 232,557 | 1,136 | 9,393,843 | 334 | 49 | 1,661 |
| 1905 | 425 | 5,721,462 | 274,585 | 2,955 | 10,396,633 | 342 | 58 | 1,705 |
| 1906 | 409 | 7,145,809 | 310,175 | 3,316 | 12,652,520 | 337 | 51 | 1,977 |
| 1907 | [b] 468 | 8,718,562 | 380,489 | 5,476 | 15,227,780 | 431 | 90 | 2,290 |

[a] Number of fires supplied.

[b] Includes 14 companies which supplied gas from oil wells only.

*Depth and gas pressure of wells in Ohio in 1906 and 1907, by counties.*

| County. | Depth, in feet. | Pressure, in pounds. |  |
|---|---|---|---|
|  |  | 1906. | 1907. |
| Allen | 1,200–1,260 | 25– 100 | 200 |
| Ashtabula | 1,997 | ........ | ........ |
| Athens | 600–1,200 | 50– 350 | 100 |
| Auglaize | 1,170–1,220 | ........ | 5–250 |
| Belmont | 1,450–1,824 | 150 | 200–275 |
| Carroll | 1,289–1,434 | ........ | 200–375 |
| Columbiana | 650– 900 | 90– 225 | 70–240 |
| Cuyahoga | 800–1,200 | ........ | ........ |
| Darke | 1,100–1,200 | ........ | 75–103 |
| Fairfield | 1,900–2,300 | 15– 300 | 40–130 |
| Guernsey | 1,050–1,250 | 250 | 400 |
| Hancock | 1,200–1,400 | 2– 250 | 85 |
| Hardin | 1,300–1,400 | 250 | ........ |
| Harrison | 703–1,600 | 100– 300 | 40–200 |
| Hocking | 2,300 | 500– 600 | ........ |
| Holmes | 700–1,000 | 210 | 215 |
| Jefferson | 700–2,026 | 200– 300 | 240 |
| Knox | 2,200–3,000 | 50– 940 | 110–400 |
| Licking | 2,100–2,485 | 300– 500 | 200–750 |
| Logan | 1,400 | 25 | 40 |
| Lucas | 1,165–1,500 | 0– 90 | 1– 90 |
| Mercer | 1,100–1,300 | 20– 43 | 2– 40 |
| Monroe | 1,400–2,000 | 136 | 400 |
| Morgan | 250–1,450 | 30– 500 | 15–500 |
| Muskingum | 1,000–1,070 | ........ | 400–425 |
| Ottawa | 1,250–1,600 | 50– 420 | 50–420 |
| Perry | 2,500 | ........ | 350–700 |
| Richland | 2,550 | 1,000–1,200 | 1,100 |
| Sandusky | 1,325–1,400 | 30– 150 | 30– 75 |
| Seneca | 485–1,400 | ........ | 15–140 |
| Van Wert | 1,200–1,270 | 75– 200 | ........ |
| Vinton | 600– 800 | ........ | 300 |
| Washington | 930–2,600 | 80– 640 | 75–350 |
| Wood | 1,200–1,400 | 10– 60 | 20 |

## INDIANA.

The following table gives the total value of gas produced in Indiana in 1907 as $1,572,605, a decrease of $178,110 as compared with 1906. The report shows an increased number of producers as compared with 1906. This is due partly to more returns from individual well owners, and also to the fact that many wells which have been abandoned by the large gas companies have been purchased by the land owners for their own use, each of whom is reported as a producer. A total of 185 productive gas wells and 56 dry holes were drilled in this State in 1907. The number of wells abandoned was 322. Fewer wells were abandoned in Decatur, Delaware, Rush, and Shelby counties than in any other county, although the pressure in these counties is generally reported as on the decline. In Decatur County, with 121 producers and 289 wells, no wells were reported as abandoned in 1907; in Delaware County, with 70 producers and 313 wells, 20 were abandoned; in Rush County, with 136 producers and 300 wells, 15 were abandoned, and in Shelby County, with 57 producers and 132 wells, 6 were abandoned. Most of the wells located in Decatur, Rush, and Shelby counties are small producers and owned by individuals who utilize the product of their wells for domestic consumption. In the other gas-producing counties of this State, which in former years produced large quantities of gas for manufacturing purposes, a gradually decreasing pressure is reported, and in some districts it is stated that the pressure is not sufficient to make the operation of plants profitable for more than another year, and that for manufacturing purposes the wells will be practically exhausted.

The report shows that the average price of gas per 1,000 cubic feet in 1907 was 23.7 cents as compared with 22.2 cents in 1906, a gain of 1.5 cents.

*Record of natural gas industry in Indiana, 1897–1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1897 | 452 | $5,009,208 | [a] 214,750 | 935 | $3,945,307 | 419 | 66 | 2,881 |
| 1898 | 533 | 5,060 969 | [a] 173,454 | 1,867 | 4,682,401 | 706 | 111 | 3,325 |
| 1899 | 571 | 6,680,370 | [a] 181,440 | 1,741 | 5,833,370 | 838 | 109 | 3,909 |
| 1900 | 670 | 7,254,539 | [a] 181,751 | 2,751 | 6,412,307 | 861 | 156 | 4,546 |
| 1901 | 656 | 6,954,566 | [a] 153,869 | 2,570 | 6,276,119 | 985 | 208 | 4,572 |
| 1902 | 929 | 7,081,344 | 101,481 | 3,282 | 6,710,080 | 1,331 | 205 | 5,820 |
| 1903 | 924 | 6,098,364 | 90,118 | 1,020 | 5,915,367 | 895 | 242 | 5,514 |
| 1904 | 846 | 4,342,400 | 84,882 | 390 | 4,282,409 | 706 | 153 | 4,684 |
| 1905 | 740 | 3,094,134 | 63,194 | 231 | 3,056,634 | 252 | 74 | 3,650 |
| 1906 | 578 | 1,750,715 | 47,368 | 156 | 1,750,755 | 159 | 46 | 3,227 |
| 1907 | [b] 687 | 1,572,605 | 46,210 | 218 | 1,570,605 | 185 | 56 | 3,090 |

[a] Number of fires supplied.

[b] Includes 32 companies which produced gas from oil wells only.

*Depth and gas pressure of wells in Indiana, in 1906 and 1907, by counties.*

| County. | Depth, in feet. | Pressure, in pounds. | |
|---|---|---|---|
| | | 1906. | 1907. |
| Bartholomew | 864-900 | 25-150 | 5-150 |
| Blackford | 940-1,060 | 1- 5 | 1- 65 |
| Daviess | 520-600 | 4- 15 | 8- 25 |
| Martin | | | |
| Decatur | 725-1,000 | 30-340 | 15-335 |
| Delaware | 728-1,200 | 1- 35 | 1- 40 |
| Grant | 900-1,100 | [a] 0- 15 | [a] 0-[b] 240 |
| Hamilton | 800-1,200 | 10-200 | 10-175 |
| Hancock | 800-1,060 | 5-200 | 5-140 |
| Harrison | 320 | 30 | 60 |
| Henry | 800-1,100 | 10-200 | 15-120 |
| Howard | 860-1,100 | 20-200 | 25-250 |
| Jay | 900-1,200 | 0-190 | 0-160 |
| Madison | 810-1,000 | ½- 50 | 1-200 |
| Miami | 927-975 | 70-100 | 20- 60 |
| Marion | 980-1,000 | ............ | 60-190 |
| Ripley | | | |
| Randolph | 950-1,140 | 25-275 | 5-260 |
| Rush | 780-1,000 | 40-350 | 25-350 |
| Shelby | 800-1,000 | 60-330 | 45-350 |
| Sullivan | 721-730 | ............ | 295 |
| Tipton | 800-1,000 | 45-215 | 40-200 |
| Wayne | 800-1,150 | 70- 75 | 50- 80 |

[a] Run on vacuum. [b] New.

## ILLINOIS.

The gas industry of Illinois is as yet of little importance compared with the crude petroleum industry of this State, but the report shows that during the year 1907 gas valued at $143,577 was consumed, as compared with gas valued at $87,211 in 1906, a gain of $56,366. Of this total value it is estimated that $37,240 worth was consumed for development and operating purposes in the oil and gas fields of the State. A total of 2,126 domestic and 61 industrial consumers were supplied with gas in 1907. The towns supplied were as follows: Annapolis, Casey, Flat Rock, Heyworth, Hutsonville, Martinsville, Marshall, Oblong, Palestine, and Robinson. Gas was piped from wells in Crawford County to Vincennes, Ind., in the latter part of 1907 for consumption in 1908. Gas was also piped from Crawford County to consumers in Lawrenceville early in January, 1908, and Birds and Pinkstaff will also be supplied.

Gas is produced in Bureau, Clark, Crawford, Cumberland, Lawrence, Lee, McLean, Pike, De Witt, and Macoupin counties. The most productive wells are located in Clark and Crawford counties, the depth of wells in Clark County being from 470 to 1,100 feet, with pressure from 50 to 200 pounds, and the wells of Crawford County varying in depth from 835 to 1,020 feet, with pressure from 150 to 400 pounds. Some very good wells are found in McLean County, the product of which is supplied to the town of Heyworth. The wells of Bureau, Lee, Pike, De Witt, and Macoupin counties are small and shallow and owned principally by individuals who use their product for domestic purposes, none being sold.

## KANSAS.

The report for 1907 shows a marked increase in the quantity and value of gas produced in Kansas. The output in 1907 exceeded in value the production of 1906 by $832,033. It will be noted that the figures representing the consumption of gas in Kansas include the value of gas piped from Kansas to Missouri. It was not advisable to give separate statements of consumption of gas in these States, as the Kansas Natural Gas Company is the only producer which pipes gas from Kansas to consumers in Missouri.

It appears from the following table that there were nearly twice as many domestic and industrial consumers in Kansas supplied with gas in 1907 as in 1906. Of 146,327 domestic consumers supplied in 1907, the Kansas Natural Gas Company, the largest producer in the State, supplied 105,000, or double the number supplied by this company in 1906. The Wichita Natural Gas Company, the second largest distributor of gas in Kansas, began to supply consumers in March, 1907. These two companies alone serve a population of about 850,000. Considerably more of the gas produced in Kansas is used for industrial than for domestic purposes. Gas is consumed in enormous quantities by the zinc smelters, most of which are also producers of gas. It is estimated that 19,615,804 thousand cubic feet of gas, valued at $443,203, were consumed by zinc smelters in 1907. Large quantities of gas are also consumed in the manufacture of brick and cement. The estimated quantity of gas consumed at brick works in Kansas in 1907 was 4,152,372 thousand cubic feet, valued at $136,843, and at cement works 11,547,500 thousand cubic feet, valued at $421,425. Gas supplied by producers to distributers of gas, to zinc, brick, and cement plants is sold at very low rates per 1,000 cubic feet, the price ranging from 1 to 3 cents per 1,000 cubic feet at the well.

There was completed in 1907 a total of 361 gas wells, some of very large volume and pressure. Mr. Sealy L. Brown, gas inspector, Montgomery County, states that the largest well drilled in Montgomery County in 1907 had a rock pressure of 325 pounds and volume of 29,400,000 cubic feet per day.

A new gas field 2 by 12 miles in area has been developed near Elmdale, Chase County. The gas sand is of fine quality, averaging in depth about 33 feet and is perfectly dry. The volume far exceeds the pressure. The gas is being supplied to consumers in Cottonwood Falls and Strong City.

There seems to be no diminution of volume or pressure of gas wells in Kansas in 1907 as compared with 1906, except in a portion of Allen and Wilson counties, where a decline is noticeable in wells which have been in constant use.

*Record of natural gas industry in Kansas, 1897–1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1897 | 10 | $105,700 | [a] 3,956 | 20 | $105,700 | 16 | 8 | 90 |
| 1898 | 29 | 174,640 | [a] 6,186 | 44 | 174,640 | 34 | 18 | 121 |
| 1899 | 31 | 332,592 | [a] 10,071 | 71 | 332,592 | 44 | 22 | 160 |
| 1900 | 32 | 356,900 | [a] 9,703 | 65 | 356,900 | 54 | 15 | 209 |
| 1901 | 48 | 659,173 | [a] 10,227 | 72 | 659,173 | 71 | 35 | 276 |
| 1902 | 80 | 824,431 | 13,488 | 91 | 824,431 | 144 | 63 | 404 |
| 1903 | 120 | 1,123,849 | 15,918 | 143 | 1,123,849 | 295 | 66 | 666 |
| 1904 | 190 | 1,517,643 | 27,204 | 298 | 1,517,643 | 378 | 135 | 1,029 |
| 1905 | 171 | 2,261,836 | 46,852 | 601 | 2,265,945 | 340 | 157 | 1,142 |
| 1906 | 130 | 4,010,986 | 79,270 | 900 | [b] 4,023,566 | 331 | 99 | 1,495 |
| 1907 | [c] 196 | 4,843,019 | 146,327 | 1,605 | [b] 4,853,298 | 361 | 163 | [d] 1,659 |

[a] Number of fires supplied.
[b] Includes gas taken from Kansas and consumed in Missouri.
[c] Includes 13 producers using gas from oil wells.
[d] Includes 28 wells which were closed in.

*Depth and gas pressure of wells in Kansas in 1906 and 1907, by counties.*

| County. | Depth, in feet. | Pressure, in pounds. | |
|---|---|---|---|
| | | 1906. | 1907. |
| Allen | 600–1,300 | 40–400 | 10–300 |
| Anderson | 240– 700 | 65–240 | 43–200 |
| Bourbon | 200– 350 | 5– 60 | 50 |
| Chase | 150– 180 | ........ | 48–100 |
| Crawford<br>Cowley | 150– 800 | 30–100 | 25–150 |
| Chautauqua | 325–1,300 | 75–320 | 50–280 |
| Douglas<br>Johnson | 350– 670 | 150–180 | 60–230 |
| Elk | 500–1,278 | 290 | 10–300 |
| Butler<br>Greenwood<br>Woodson | 365–1,425 | 80–300 | 75–450 |
| Labette | 500– 925 | 250–285 | 80–200 |
| Linn | 200– 600 | 25–185 | 9–175 |
| Franklin<br>Miami | 300– 625 | 70– 75 | 20–225 |
| Montgomery | 258–1,500 | 100–650 | 25–530 |
| Neosho | 515–1,000 | 90–300 | 40–225 |
| Wilson | 228–1,100 | 135–400 | 70–395 |
| Wyandotte | 600 | ........ | 175 |

## MISSOURI.

Gas is produced in small quantities in Bates, Cass, Clay, and Jackson counties, Mo. The gas from several small wells in Bates County is used by the owners for domestic purposes. Domestic consumers in Belton, West Line, and Holt are supplied with gas from a few small wells in Cass and Clay counties. In 1907 considerable development work was done in Cass and Jackson counties, and several wells, producing both oil and gas, were drilled, but all have been capped for future use. Most of the gas consumed in this State is supplied from the Kansas gas fields by the Kansas Natural Gas Company. Some of the cities supplied are: St. Joseph, Weston, Kansas City, Carl Junction, Joplin, Oronogo, Webb City, Carterville, Purcell, Neck City, Alba, and Carthage.

The approximate value of gas produced from wells in Missouri and consumed in 1907 was $17,010.

## OKLAHOMA.

*Record of natural gas industry in Oklahoma in 1906 and 1907.*

| Year. | Gas produced. | | Gas consumed. | | | Wells. | | |
|---|---|---|---|---|---|---|---|---|
| | Number of producers. | Value. | Number of consumers. | | Value. | Drilled. | | Productive Dec. 31. |
| | | | Domestic. | Industrial. | | Gas. | Dry. | |
| 1906 | 50 | $259,862 | 8,391 | 202 | $247,282 | 81 | 33 | 239 |
| 1907 | [a] 107 | [b] 417,221 | 11,038 | 277 | [b] 406,942 | 99 | 41 | [c] 315 |

[a] Includes 12 companies using gas from oil wells only.
[b] Includes gas valued at $71,233 and used for developing and operating purposes in the oil and gas fields.
[c] Includes 87 wells "shut in," in 1907.

Oklahoma takes first place as a producer of crude petroleum in 1907 and seventh place in the value of gas produced. While it is fortunate in having an abundant supply of gas, there is no market for all of the product, and many of the gas wells have been shut in. In the year 1907 there was completed a total of 99 gas wells, making the total number of productive gas wells at the close of the year 315, of which 87 were shut in. The wells range in daily capacity from 2,000,000 cubic feet to 40,000,000 cubic feet.

Most of the gas furnished to consumers in this State is supplied at flat rates. A total of 11,038 domestic consumers were supplied with gas, valued at $244,050, in 1907. The following towns were wholly or partially supplied: Bartlesville, Cleveland, Tulsa, Ramona, Pawhuska, Ponca City, Sapulpa, Muskogee, Claremore, Inola, Collinsville, Ocheleta, Bigheart, Nowata, Lenepah, Skiatook, Oologah, Gotebo, Okmulgee, Blackwell, Wagoner, Owasso, Vinita, Lawton, and Mounds. Oklahoma City and Ardmore began the consumption of gas late in December, 1907. The approximate value of the gas used for industrial purposes in 1907 was $162,892. There are few manufacturing establishments in this State, and most of the gas used for industrial purposes was supplied to ice, electric, brick, and power plants. Large quantities of the gas are used for operating and developing purposes in the oil and gas fields. One zinc works at Bartlesville began the use of gas late in 1907.

*Depth of wells in Oklahoma, by districts.*

| District. | Depth, in feet. |
|---|---|
| Cherokee Nation | 500–1,400 |
| Chickasaw Nation | 400–1,190 |
| Comanche | |
| Creek Nation | 1,205–1,700 |
| Kay | 500–1,200 |
| Kiowa | 375– 390 |
| Osage Nation | 870–2,100 |
| Pawnee | 1,600–1,700 |

## ALABAMA.

During the year 1907 three gas wells were completed in Madison County, Ala., by the New York-Alabama Oil Company, making a total of 11 productive gas well at the close of 1907, the product of which was supplied to consumers in Huntsville and suburbs. The average depth of the wells is 400 feet. The gas is excellent for both illuminating and heating.

As there is but one company supplying gas to consumers in this State, the quantity and value of the gas consumed have been combined with the figures for Louisiana and Texas.

## ARKANSAS.

The only gas field so far developed in Arkansas is located near Fort Smith, Sebastian County. Three companies are in operation, two of which are supplying consumers with gas from their wells, and the third is making preparations to supply consumers. A total of 58 gas wells had been drilled in this field to the close of 1907. The gas field has not been drawn upon sufficiently to determine anything about the life of the field. The depth of wells varies from 1,319 feet to 3,175 feet. The main flow of gas is found from 30 to 35 feet within a 250-foot sand at a depth ranging from 1,270 to 1,375 feet. The pay streak varies greatly from a few inches to 15 feet. All the gas sands are wholly without water, consequently the rock pressure is not high. No water has been encountered below 580 feet, and but few of the wells show any water at all below 150 feet. Pressure varies from 135 to 280 pounds. There has been no showing of oil. There is no sulphur in the gas, which is very clean and high in heat units. It is as good gas as is known for fuel and lighting. Two wells of 4,000,000 cubic feet capacity were brought in in 1907. Domestic and industrial consumers were supplied in Fort Smith, Van Buren, Huntington, and Mansfield in 1907, and Greenwood will be supplied in 1908.

A well was drilled in Pope County, Ark., in 1907, and gas was found at 1,170 feet but not in commercial quantities. Artesian water was struck at 1,190 feet, and the well was abandoned. A second well is drilling. A well was also drilled to a depth of 1,704 feet in Pulaski County in 1907 with slight indications of gas. In a well drilled in Conway County gas was struck at a depth of 2,200 feet, but not in commercial quantities. Drilling is still in progress.

## LOUISIANA.

The gas field of Louisiana is located in Caddo Parish, and is one of the greatest gas fields of the United States. Some tremendous blow-outs have occurred in this field, and millions of feet of gas have been wasted, there being no disposition to confine the product on account of the great pressure. This field lies 20 miles north of Shreveport. The gas wells have a depth of from 840 to 2,150 feet. Five very good gas wells were completed in 1907, 2 of which have an estimated daily capacity of from 35,000,000 to 50,000,000 cubic feet. Gas from the wells in the Caddo field has been piped to the following-named towns, where it is supplied to consumers for domestic and industrial purposes: Shreveport, Caddo City, Blanchard, Mooringsport, Bozier City, and Texarkana.

As there was but 1 natural gas producer of importance supplying consumers in Louisiana, the figures of this State have been included with those of Alabama and Texas.

### TEXAS.

Practically all the gas consumed in Texas in 1907 for domestic purposes and nearly all used for industrial purposes was produced from wells in Navarro County. A small quantity of gas was produced and used in the oil field of Harris County. Most of the gas utilized for industrial purposes was consumed in developing and operating in the oil fields of the State.

In September, 1907, a very good gas well was completed near Petrolea in the Clay County oil field by the Clayco Oil and Pipe Line Company, and up to the present time this is the only gas well in this field. The well has a depth of 1,500 feet. In a test of 4 minutes it showed a pressure of 475 pounds, this being the only test made. It has an estimated daily capacity of from 8,000,000 to 10,000,000 cubic feet, and will be used for steam and pumping purposes in the oil field.

### SOUTH DAKOTA.

Little can be added to that which has been given in previous reports concerning the production of gas in South Dakota. Gas is produced from artesian wells in Hughes, Stanley, Sully, and Walworth counties. For several years consumers in Pierre have been supplied with gas from wells in Hughes County, the gas being utilized for heating, lighting, and power purposes. Fort Pierre has been using gas from a well in Stanley County since October 1, 1907. This well produces a high-grade carbon gas, very good for light, fuel, and power. It comes with a flow of warm water and is separated from the water in an air-tight tank under pressure. A few wells are producing gas in Sully County, a small quantity of the gas being utilized on ranches where the wells are located. A little gas is being consumed from a well on Iowa Ranch, Walworth County.

### COLORADO.

There has been no change in the natural-gas situation in Colorado since the last report. Most of the gas produced comes from a well 1¾ miles east of the town of Boulder and is supplied to domestic and industrial consumers in Boulder. A small quantity of gas is produced from oil wells and is consumed in the Florence oil field. A small gas well was drilled during prospecting for oil in Las Animas County in 1900, part of the product of which is consumed for domestic purposes.

### WYOMING.

Very little gas was consumed in the State of Wyoming in 1907. A small quantity of gas was produced from wells in Converse County and was used for boiler and ranch purposes. Three wells, producing oil and gas, were completed by the Montana and Wyoming Oil Comrany in Big Horn County. A large flow of gas was struck at 300 feet, and oil at 550 feet. A gas well of considerable volume was completed in 1907 at Gray Bull, Big Horn County, at a depth of 801 feet, but the product has not been utilized.

## CALIFORNIA.

The total value of the gas consumed in California in 1907 was $168,397, of which $33,541 is estimated as the value of the gas produced from oil wells and consumed in the oil fields of the State. Deducting this amount from the total leaves $134,856 as the value of gas supplied to domestic and industrial consumers. The names of the counties in which gas wells are located and gas was consumed in 1907 are: Los Angeles, Sacramento, San Joaquin, Santa Barbara, Tehama, Ventura, and Solana. One gas well is reported in each of the counties of Napa and Contra Costa, but they have not been put to use. The following-named towns have been wholly or partly supplied with gas in 1907: Sacramento, Stockton, Summerland, Santa Maria, Oxnard, Ventura, and Suisun City.

## NORTH DAKOTA.

North Dakota has been added to the list of gas-producing States. Two gas wells have been drilled in Bottineau County to a depth of 174 and 180 feet, respectively, the product being utilized by 2 consumers. It is estimated that one of these wells will flow 2,000,000 cubic feet of gas daily. It is reported that there is a gas belt about 15 or 20 miles in length and 8 or 10 miles in breadth in La Moure County, which produces a fine quality of gas. Eight small wells have been drilled, the product of 1 being used for domestic purposes by the owner of the well. These wells are from 1,278 to 1,500 feet deep.

## OREGON.

There are in Malheur County, Oregon, a total of 16 artesian wells which produce gas, but so far as known the gas from 1 well only has been utilized, supplying one dwelling with light and heat. It is also reported that gas from an artesian well near Astoria, Clatsop County, has been used to light one or two houses in that locality.

## CANADA.

*Ontario.*—The following statistics regarding the production of natural gas in Ontario, Canada, have been furnished by the Ontario Bureau of Mines, Toronto:

*Statistics of natural-gas production in the Province of Ontario, Canada, 1902–1907.*

| Year. | Producing wells. | Miles of gas pipe. | Workmen employed. | Value of gas product. | Wages for labor. |
|---|---|---|---|---|---|
| 1902 | 169 | 369 | 107 | $195,992 | $55,618 |
| 1903 | 210 | 312 | 138 | 196,535 | 79,945 |
| 1904 | 176 | 231 | ........ | 253,524 | 53,674 |
| 1905 | 273 | 462½ | 130 | [a] 316,476 | 88,865 |
| 1906 | 332 | 550 | 108 | 533,446 | 64,968 |
| 1907 | 582 | 810 | 191 | 746,499 | 110,832 |

[a] In addition gas valued at $33,000 was produced from 12 wells at Medicine Hat, Alberta, Canada.

## IMPORTS.

The imports of natural gas for consumption during the last five years have been as follows:

*Value of natural gas imported for consumption, 1903–1907.*

| | | | |
|---|---|---|---|
| 1903 | $32,802 | 1906 | $36,906 |
| 1904 | 34,828 | 1907 | 32,107 |
| 1905 | 49,237 | | |

No exports of natural gas during 1907 were reported.

# PETROLEUM.

### By David T. Day.

## INTRODUCTION.

The petroleum production of the United States in 1907 was characterized by (1) a total output far in excess of any previous year, (2) an unparalleled accumulation of stocks, in spite of which (3) the price of all grades of oil was kept at a high level, the prices in California showing important advances.

The sensational developments in production were the great increase in the new Illinois field and the phenomenal yield of the Glenn pool in Oklahoma, together with increase in both quantity and price in California.

## PRODUCTION.

The table which follows this paragraph shows that the total product increased from 126,493,936 barrels,[a] or 16,868,599 metric tons, in 1906 to 166,095,335 barrels, or 22,149,862 metric tons, in 1907. The increase shown for 1907 over 1906 is 39,601,399 barrels, or more than the total product of petroleum in any year up to 1889. The total value increased from $92,444,735 in 1906 to $120,106,749 in 1907. The average price decreased only slightly, from $0.731 per barrel in 1906 to $0.723 in 1907. The Illinois and Mid-Continent fields contributed most materially to the increase, although the gain of over 6,500,000 barrels in California was noteworthy and unexpected.

*Total quantity and value of crude petroleum produced in the United States and the average price per barrel in 1906 and 1907, by States.*

| State. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity (barrels). | Value. | Average price per barrel. | Quantity (barrels). | Value. | Average price per barrel. |
| California | 33,098,598 | $9,553,430 | $0.289 | 39,748,375 | $14,699,956 | $0.370 |
| Colorado | 327,582 | 262,675 | .802 | 331,851 | 272,813 | .822 |
| Illinois | 4,397,050 | 3,274,818 | .745 | 24,281,973 | 16,432,947 | .677 |
| Indiana | 7,673,477 | 6,770,066 | .882 | 5,128,037 | 4,536,930 | .885 |
| Kansas<br>Oklahoma | 21,718,648 | 9,615,198 | .443 | 45,933,649 | 18,478,658 | .402 |
| Kentucky<br>Tennessee | 1,213,548 | 1,031,629 | .850 | 820,844 | 862,396 | 1.051 |
| Louisiana | 9,077,528 | 3,557,838 | .392 | 5,000,221 | 4,063,033 | .813 |
| Michigan<br>Missouri | 3,500 | 4,890 | 1.397 | 4,000 | 6,500 | 1.625 |
| New York | 1,243,517 | 1,995,377 | 1.605 | 1,212,300 | 2,127,748 | 1.755 |
| Ohio | 14,787,763 | 16,997,000 | 1.149 | 12,207,448 | 14,769,888 | 1.210 |
| Pennsylvania | 10,256,893 | 16,596,943 | 1.618 | 9,999,306 | 17,579,706 | 1.758 |
| Texas | 12,567,897 | 6,565,578 | .522 | 12,322,696 | 10,401,863 | .844 |
| Utah | ........ | ........ | ........ | 9,339 | 21,883 | 2.343 |
| Wyoming | 7,000 | 49,000 | 7.000 | | | |
| West Virginia | 10,120,935 | 16,170,293 | 1.598 | 9,095,296 | 15,852,428 | 1.743 |
| Total | 126,493,936 | 92,444,735 | .731 | 166,095,335 | 120,106,749 | .723 |

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[a] The barrel used in this report, unless otherwise specified, is the United States standard barre containing 42 Winchester gallons.

The increase or decrease in the production by States, as well as the percentage of increase or decrease in 1907 compared with 1906, are shown in the following table:

*Total production of crude petroleum and percentage of increase or decrease, by States, in 1907, as compared with 1906, in barrels.*

| State. | Production. | | Increase. | Decrease. | Percentage. | |
|---|---|---|---|---|---|---|
| | 1906. | 1907. | | | Increase. | Decrease. |
| California | 33,098,598 | 39,748,375 | 6,649,777 | | 20.09 | |
| Colorado | 327,582 | 331,851 | 4,269 | | 1.30 | |
| Illinois | 4,397,050 | 24,281,973 | 19,884,923 | | 452.23 | |
| Indiana | 7,673,477 | 5,128,037 | | 2,545,440 | | 33.17 |
| Kansas<br>Oklahoma | 21,718,648 | 45,933,649 | 24,215,001 | | 111.50 | |
| Kentucky<br>Tennessee | 1,213,548 | 820,844 | | 392,704 | | 32.36 |
| Louisiana | 9,077,528 | 5,000,221 | | 4,077,307 | | 44.92 |
| Michigan<br>Missouri | 3,500 | 4,000 | 500 | | 14.28 | |
| New York | 1,243,517 | 1,212,300 | | 31,217 | | 2.51 |
| Ohio | 14,787,763 | 12,207,448 | | 2,580,315 | | 17.45 |
| Pennsylvania | 10,256,893 | 9,999,306 | | 257,587 | | 2.51 |
| Texas | 12,567,897 | 12,322,696 | | 245,201 | | 1.95 |
| Utah<br>Wyoming | <br>7,000 | 9,339 | 2,339 | | 33.41 | |
| West Virginia | 10,120,935 | 9,095,296 | | 1,025,639 | | 10.13 |
| Total | 126,493,936 | 166,095,335 | 39,601,399 | | 31.307 | |

## RANK OF PRODUCING STATES.

### QUANTITY.

Oklahoma and Kansas exchanged places with California in 1907 as leading States in quantity of oil produced. The greatest change, however, was in Illinois, where the increased production brought this State to third place, with a production more than fivefold that of 1906 and practically double that of Texas, which was fourth in both years. These were the significant changes in quantity, the production in other States following the course of previous years, with indications that the order of 1907 will prevail for the next year or two.

*Rank of petroleum-producing States and Territories, with quantity produced and percentage of each in 1906 and 1907, in barrels.*

| 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|
| State. | Rank. | Quantity. | Percentage. | State. | Rank. | Quantity. | Percentage. |
| California | 1 | 33,098,598 | 26.17 | Oklahoma<br>Kansas | 1 | [a] 45,933,649 | 27.65 |
| Kansas<br>Oklahoma | 2 | 21,718,648 | 17.17 | California | 2 | 39,748,375 | 23.93 |
| Ohio | 3 | 14,787,763 | 11.69 | Illinois | 3 | 24,281,973 | 14.62 |
| Texas | 4 | 12,567,897 | 9.93 | Texas | 4 | 12,322,696 | 7.42 |
| Pennsylvania | 5 | 10,256,893 | 8.11 | Ohio | 5 | 12,207,448 | 7.35 |
| West Virginia | 6 | 10,120,935 | 8.00 | Pennsylvania | 6 | 9,999,306 | 6.02 |
| Louisiana | 7 | 9,077,528 | 7.18 | West Virginia | 7 | 9,095,296 | 5.48 |
| Indiana | 8 | 7,673,477 | 6.07 | Indiana | 8 | 5,128,037 | 3.09 |
| Illinois | 9 | 4,397,050 | 3.47 | Louisiana | 9 | 5,000,221 | 3.01 |
| New York | 10 | 1,243,517 | .98 | New York | 10 | 1,212,300 | .73 |
| Kentucky<br>Tennessee | 11 | 1,213,548 | .96 | Kentucky<br>Tennessee | 11 | 820,844 | .49 |
| Colorado | 12 | 327,582 | .26 | Colorado | 12 | 331,851 | .20 |
| Utah<br>Wyoming | 13 | 7,000 | .01 | Utah<br>Wyoming | 13 | 9,339 | .01 |
| Michigan<br>Missouri | 14 | 3,500 | | Michigan<br>Missouri | 14 | 4,000 | |
| Total | | 126,493,936 | 100.00 | Total | | 166,095,335 | 100.00 |

[a] Production of Oklahoma estimated at 44,300,149 barrels; that of Kansas at 1,633,500 barrels.

## VALUE.

The rank of the States according to value of the product is more significant than their rank according to volume, as value reflects the utility of the product. In this respect the changes were also quite radical.

In spite of a comparatively low price per barrel, the Mid-Continent product rose in value from fourth to first place, because of the great yield of the Glenn pool, and because the completion of two pipe lines to the Gulf gave an outlet which, together with the decline in Louisiana, steadied the Mid-Continent price. The Illinois price was also sustained well enough, in spite of the great output, to make the value advance from ninth to third place, while California's increased production and price only sufficed to leave the value in sixth place, as in 1906. In this respect an advance will probably be seen in 1908, due to the great demand for California's product.

It was not until 1895 that the total value of all the oil produced in the United States amounted to as much as the increase in value of the output of 1907 over that of 1906.

*Rank of petroleum-producing States and Territories, with value of production and percentage of each, in 1906 and 1907.*

| 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|
| State. | Rank. | Value. | Percentage. | State. | Rank. | Value. | Percentage. |
| Ohio | 1 | $16,997,000 | 18.39 | Oklahoma | 1 | [a] $18,478,658 | 15.38 |
| Pennsylvania | 2 | 16,596,943 | 17.95 | Kansas | | | |
| West Virginia | 3 | 16,170,293 | 17.49 | Pennsylvania | 2 | 17,579,706 | 14.64 |
| Kansas | 4 | 9,615,198 | 10.40 | Illinois | 3 | 16,432,947 | 13.08 |
| Oklahoma | | | | West Virginia | 4 | 15,852,428 | 13.20 |
| California | 5 | 9,553,430 | 10.34 | Ohio | 5 | 14,769,888 | 12.30 |
| Indiana | 6 | 6,770,066 | 7.32 | California | 6 | 14,699,956 | 12.24 |
| Texas | 7 | 6,565,578 | 7.10 | Texas | 7 | 10,401,863 | 8.66 |
| Louisiana | 8 | 3,557,838 | 3.85 | Indiana | 8 | 4,536,930 | 3.78 |
| Illinois | 9 | 3,274,818 | 3.54 | Louisiana | 9 | 4,063,033 | 3.38 |
| New York | 10 | 1,995,377 | 2.16 | New York | 10 | 2,127,748 | 1.77 |
| Kentucky | 11 | 1,031,629 | 1.12 | Kentucky | 11 | 862,396 | .72 |
| Tennessee | | | | Tennessee | | | |
| Colorado | 12 | 262,675 | .28 | Colorado | 12 | 272,813 | .23 |
| Utah | 13 | 53,890 | .06 | Utah | 13 | 28,383 | .02 |
| Wyoming | | | | Wyoming | | | |
| Michigan | | | | Michigan | | | |
| Missouri | | | | Missouri | | | |
| Total | | 92,444,735 | 100.00 | Total | | 120,106,749 | 100.00 |

[a] Value of Oklahoma crude petroleum estimated at $17,824,342; that of Kansas at $654,316.

## PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES FROM 1859 TO 1907, INCLUSIVE.

In the following table will be found a statement of the production of crude petroleum from each State of the United States from the year 1859 to and including the production of the year 1907:

*Production of crude petroleum in the United States, 1859–1907, by years and by States, in barrels of 42 gallons.*

| Year | Pennsylvania and New York. | Ohio. | West Virginia. | California. | Kentucky and Tennessee. | Colorado. | Indiana. | Illinois. |
|---|---|---|---|---|---|---|---|---|
| 1859 | 2,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1860 | 500,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1861 | 2,113,609 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1862 | 3,056,690 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1863 | 2,611,309 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1864 | 2,116,109 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1865 | 2,497,700 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1866 | 3,597,700 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1867 | 3,347,300 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1868 | 3,646,117 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1869 | 4,215,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1870 | 5,260,745 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1871 | 5,205,234 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1872 | 6,293,194 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1873 | 9,893,786 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1874 | 10,926,945 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1875 | 8,787,514 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1876 | 8,968,906 | 31,763 | 120,000 | 12,000 | ........ | ........ | ........ | ........ |
| 1877 | 13,135,475 | 29,888 | 172,000 | 13,000 | ........ | ........ | ........ | ........ |
| 1878 | 15,163,462 | 38,179 | 180,000 | 15,227 | ........ | ........ | ........ | ........ |
| 1879 | 19,685,176 | 29,112 | 180,000 | 19,858 | ........ | ........ | ........ | ........ |
| 1880 | 26,027,631 | 38,940 | 179,000 | 40,552 | ........ | ........ | ........ | ........ |
| 1881 | 27,376,509 | 33,867 | 151,000 | 99,862 | ........ | ........ | ........ | ........ |
| 1882 | 30,053,500 | 39,761 | 128,000 | 128,636 | ........ | ........ | ........ | ........ |
| 1883 | 23,128,389 | 47,632 | 126,000 | 142,857 | 4,755 | ........ | ........ | ........ |
| 1884 | 23,772,209 | 90,081 | 90,000 | 262,000 | 4,148 | ........ | ........ | ........ |
| 1885 | 20,776,041 | 661,580 | 91,000 | 325,000 | 5,164 | ........ | ........ | ........ |
| 1886 | 25,798,000 | 1,782,970 | 102,000 | 377,145 | 4,726 | ........ | ........ | ........ |
| 1887 | 22,356,193 | 5,022,632 | 145,000 | 678,572 | 4,791 | 76,295 | ........ | ........ |
| 1888 | 16,488,668 | 10,010,868 | 119,448 | 690,333 | 5,096 | 297,612 | ........ | ........ |
| 1889 | 21,487,435 | 12,471,466 | 544,113 | 303,220 | 5,400 | 316,476 | 33,375 | 1,460 |
| 1890 | 28,458,208 | 16,124,656 | 492,578 | 307,360 | 6,000 | 368,842 | 63,496 | 900 |
| 1891 | 33,009,236 | 17,740,301 | 2,406,218 | 323,600 | 9,000 | 665,482 | 136,634 | 675 |
| 1892 | 28,422,377 | 16,362,921 | 3,810,086 | 385,049 | 6,500 | 824,000 | 698,068 | 521 |
| 1893 | 20,314;513 | 16,249,769 | 8,445,412 | 470,179 | 3,000 | 594,390 | 2,335,293 | 400 |
| 1894 | 19,019,990 | 16,792,154 | 8,577,624 | 705,969 | 1,500 | 515,746 | 3,688,666 | 300 |
| 1895 | 19,144,390 | 19,545,233 | 8,120,125 | 1,208,482 | 1,500 | 438,232 | 4,386,132 | 200 |
| 1896 | 20,584,421 | 23,941,169 | 10,019,770 | 1,252,777 | 1,680 | 361,450 | 4,680,732 | 250 |
| 1897 | 19,262,066 | 21,560,515 | 13,090,045 | 1,903,411 | 322 | 384,934 | 4,122,356 | 500 |
| 1898 | 15,948,464 | 18,738,708 | 13,615,101 | 2,257,207 | 5,568 | 444,383 | 3,730,907 | 360 |
| 1899 | 14,374,512 | 21,142,108 | 13,910,630 | 2,642,095 | 18,280 | 390,278 | 3,848,182 | 360 |
| 1900 | 14,559,127 | 22,362,730 | 16,195,675 | 4,324,484 | 62,259 | 317,385 | 4,874,392 | 200 |
| 1901 | 13,831,996 | 21,648,083 | 14,177,126 | 8,786,330 | 137,259 | 460,520 | 5,757,086 | 250 |
| 1902 | 13,183,610 | 21,014,231 | 13,513,345 | 13,984,268 | 185,331 | 396,901 | 7,480,896 | 200 |
| 1903 | 12,518,134 | 20,480,286 | 12,899,395 | 24,382,472 | 554,286 | 483,925 | 9,186,411 | ........ |
| 1904 | 12,239,026 | 18,876,631 | 12,644,686 | 29,649,434 | 998,284 | 501,763 | 11,339,124 | ........ |
| 1905 | 11,554,777 | 16,346,660 | 11,578,110 | 33,427,473 | 1,217,337 | 376,238 | 10,964,247 | 181,084 |
| 1906 | 11,500,410 | 14,787,763 | 10,120,935 | 33,098,598 | 1,213,548 | 327,582 | 7,673,477 | 4,397,050 |
| 1907 | 11,211,606 | 12,207,448 | 9,095,296 | 39,748,375 | 820,844 | 331,851 | 5,128,037 | 24,281,973 |
| Total | 687,425,409 | 366,250,105 | 185,039,718 | 201,965,825 | 5,276,578 | 8,874,285 | 90,127,511 | 28,866,683 |

*Production of crude petroleum in the United States, 1859–1907, by years and by States, in barrels of 42 gallons*—Continued.

| Year. | Kansas. | Texas. | Missouri. | Oklahoma. | Wyoming. | Louisiana. | United States. | Total value. |
|---|---|---|---|---|---|---|---|---|
| 1859 |  |  |  |  |  |  | 2,000 | $32,000 |
| 1860 |  |  |  |  |  |  | 500,000 | 4,800,000 |
| 1861 |  |  |  |  |  |  | 2,113,609 | 1,035,668 |
| 1862 |  |  |  |  |  |  | 3,056,690 | 3,209,525 |
| 1863 |  |  |  |  |  |  | 2,611,309 | 8,225,663 |
| 1864 |  |  |  |  |  |  | 2,116,109 | 20,896,576 |
| 1865 |  |  |  |  |  |  | 2,497,700 | 16,459,853 |
| 1866 |  |  |  |  |  |  | 3,597,700 | 13,455,398 |
| 1867 |  |  |  |  |  |  | 3,347,300 | 8,066,993 |
| 1868 |  |  |  |  |  |  | 3,646,117 | 13,217,174 |
| 1869 |  |  |  |  |  |  | 4,215,000 | 23,730,450 |
| 1870 |  |  |  |  |  |  | 5,260,745 | 20,503,754 |
| 1871 |  |  |  |  |  |  | 5,205,234 | 22,591,180 |
| 1872 |  |  |  |  |  |  | 6,293,194 | 21,440,503 |
| 1873 |  |  |  |  |  |  | 9,893,786 | 18,100,464 |
| 1874 |  |  |  |  |  |  | 10,926,945 | 12,647,527 |
| 1875 |  |  |  |  |  |  | 8,787,514 | 7,368,133 |
| 1876 |  |  |  |  |  |  | 9,132,669 | 22,982,822 |
| 1877 |  |  |  |  |  |  | 13,350,363 | 31,788,566 |
| 1878 |  |  |  |  |  |  | 15,396,868 | 18,044,520 |
| 1879 |  |  |  |  |  |  | 19,914,146 | 17,210,708 |
| 1880 |  |  |  |  |  |  | 26,286,123 | 24,600,638 |
| 1881 |  |  |  |  |  |  | 27,661,238 | 23,512,051 |
| 1882 |  |  |  |  |  |  | 30,349,897 | 23,631,165 |
| 1883 |  |  |  |  |  |  | 23,449,633 | 25,740,252 |
| 1884 |  |  |  |  |  |  | 24,218,438 | 20,476,924 |
| 1885 |  |  |  |  |  |  | 21,858,785 | 19,193,694 |
| 1886 |  |  |  |  |  |  | 28,064,841 | 20,028,457 |
| 1887 |  |  |  |  |  |  | 28,283,483 | 18,856,606 |
| 1888 |  |  |  |  |  |  | 27,612,025 | 17,950,353 |
| 1889 | 500 | 48 | 20 |  |  |  | 35,163,513 | 26,963,340 |
| 1890 | 1,200 | 54 | 278 |  |  |  | 45,823,572 | 35,365,105 |
| 1891 | 1,400 | 54 | 25 | 30 |  |  | 54,292,655 | 30,526,553 |
| 1892 | 5,000 | 45 | 10 | 80 |  |  | 50,514,657 | 25,906,463 |
| 1893 | 18,000 | 50 | 50 | 10 |  |  | 48,431,066 | 28,932,826 |
| 1894 | 40,000 | 60 | 8 | 130 | 2,369 |  | 49,344,516 | 35,522,095 |
| 1895 | 44,430 | 50 | 10 | 37 | 3,455 |  | 52,892,276 | 57,691,279 |
| 1896 | 113,571 | 1,450 | 43 | 170 | 2,878 |  | 60,960,361 | 58,518,709 |
| 1897 | 81,098 | 65,975 | 19 | 625 | 3,650 |  | 60,475,516 | 40,929,611 |
| 1898 | 71,980 | 546,070 | 10 |  | 5,475 |  | 55,364,233 | 44,193,359 |
| 1899 | 69,700 | 669,013 | 132 |  | 5,560 |  | 57,070,850 | 64,603,904 |
| 1900 | 74,714 | 836,039 | [a]1,602 | 6,472 | 5,450 |  | 63,620,529 | 75,752,691 |
| 1901 | 179,151 | 4,393,658 | [b]2,335 | 10,000 | 5,400 |  | 69,389,194 | 66,417,335 |
| 1902 | 331,749 | 18,083,658 | [a]757 | 37,100 | 6,253 | 548,617 | 88,766,916 | 71,178,910 |
| 1903 | 932,214 | 17,955,572 | [a]3,000 | 138,911 | 8,960 | 917,771 | 100,461,337 | 94,694,050 |
| 1904 | 4,250,779 | 22,241,413 | [a]2,572 | 1,366,748 | 11,542 | 2,958,958 | 117,080,960 | 101,175,455 |
| 1905 | [c]12,013,495 | 28,136,189 | [a]3,100 | ([d]) | 8,454 | 8,910,416 | 134,717,580 | 84,157,399 |
| 1906 | [c]21,718,648 | 12,567,897 | [a]3,500 | ([d]) | [e]7,000 | 9,077,528 | 126,493,936 | 92,444,735 |
| 1907 | [c]45,933,649 | 12,322,696 | [a]4,000 | ([d]) | 9,339 | 5,000,221 | 166,095,335 | 120,106,749 |
| Total | 85,881,278 | 117,819,991 | 21,471 | 1,560,313 | 85,785 | 27,413,511 | 1,806,608,463 | 1,654,877,685 |

[a] Includes the production of Michigan.
[b] Includes production of Michigan and small production in Oklahoma.
[c] Includes production of Oklahoma.
[d] Included with Kansas.
[e] Estimated.

## CONSUMPTION OF FUEL OIL BY RAILROADS IN 1907.

During the year 1907 a total of 18,855,691 barrels of oil were consumed as fuel by the railroads of the United States, as against a total of 15,577,677 barrels in 1906. The estimated length of line operated by the use of fuel oil in 1907 was 13,593 miles, and the total length of line covered by oil-burning engines is estimated at 74,197,144 miles, an average of 3.935 miles per barrel of oil consumed. Most of the oil consumed was crude oil, the remainder being residuum from the refineries, the product remaining after the lighter oils have been extracted.

The railroads of the United States on which oil-burning engines were used in 1907 were as follows: The San Pedro, Los Angeles and Salt Lake Railroad; the Sunset lines of California, Texas, and Louisiana; the Frisco lines of Kansas and Texas; the Kansas City Southern Railway of Texas and Louisiana; the Santa Fe lines; the International and Great Northern Railway, the Houston, East and West Texas Railway, the Gulf and Inter-State Railway, the St. Louis, Brownsville and Mexico Railroad—all of Texas; and the Missouri, Kansas and Texas Railway system of Kansas and Oklahoma.

Practically all of this oil was from the West—that is, from the Mid-continent, Gulf, and California fields.

## OIL FIELDS OF THE UNITED STATES.

The five great oil provinces of the United States, which have been sufficiently outlined in previous reports of this series, showed only slight changes in geographical extent, but the changes in their relative importance constituted the phenomenal feature of the year.

The trade custom of grouping the oils according to the quality produced has become more general, so that oils are now described as of the various "grades," such as the "Kansas grade," "Lima grade," "Pennsylvania grade," etc., the distinction being based primarily on the percentage of sulphur, which determines whether the oil requires special treatment to eliminate this element. The second criterion is the proportion of asphalt and paraffin wax to the illuminating oil obtainable from the crude.

Briefly described these fields are:

*Appalachian field.*—The oils of the Appalachian field are practically free from sulphur and asphalt, are rich in paraffin wax, and yield the largest percentage of gasoline and illuminating oils. The field extends from western New York in a general southwesterly direction along the western side of the Allegheny Mountains, through Pennsylvania, eastern Ohio, West Virginia, into Kentucky and Tennessee. In the latter States the quality of the oil varies so markedly within short distances that the product frequently resembles the sulphur oils of the Lima-Indiana field.

*Lima-Indiana field.*—The Lima-Indiana field yields oil with sufficient sulphur to require special treatment for its elimination. Like the Appalachian oil it yields paraffin wax. The field includes the northwestern part of Ohio and a strip in the middle of Indiana. The Illinois field is no longer included.

*Illinois field.*—It was stated in the report for 1906 that there was doubt as to the advisability of including the Illinois field with the

Lima-Indiana, because the oil is produced from a different geologic horizon. The examination of the oil confirms the necessity of making this a separate field. The oil contains less sulphur, much of it being refined without special treatment. On the other hand, some of it contains asphalt as well as paraffin. The oils vary within wide limits in gravity and distillation products. The oil comes chiefly from a narrow field in southeastern Illinois near the Indiana line, though much drilling is in progress over the State by which small isolated pools have developed.

*Mid-Continent field.*—The oils of the Mid-Continent field show considerable variation. Many contain both asphalt and paraffin, especially in Kansas. The field includes southeastern Kansas, Oklahoma, and northern Texas.

*Gulf field.*—Geographically this field includes all oils in Texas and Louisiana. The oils near the Gulf contain considerable quantities of sulphur, much of which is in the form of sulphuretted hydrogen and easily removed by steam before refining or use as fuel. Their location makes them well suited for fuel oils, especially for export. They also yield valuable lubricating oils, and the gasoline derived from them is a better solvent than that from other fields. The oils of northern Texas, notably from Corsicana, are lighter and contain less sulphur. Statistically this region has been split off from the Gulf field and combined for industrial distinction with the Mid-Continent field.

*California field.*—The California oils are generally characterized by much asphalt and little or no paraffin, but in the future a division of the field will be required on account of the increased yield of oils of lighter grade from the Santa Maria district and probably from the Monterey district also, and the suitability of these oils for the increased demand for refining.

*Other fields.*—Small quantities of oil have been produced for many years in Wyoming, Colorado, Missouri, and Michigan. A map of the occurrence of oil indicates its presence in several other States—Montana, Washington, and western Oregon, and, lately, eastern Oregon, Idaho, and Nevada. During 1907 a small field of heavy oil was developed in southwestern Utah. Of all these, Wyoming gives most promise for the future.

## FIELD INVESTIGATIONS IN 1907 AND 1908.

During the year 1907 the work in the various oil fields by members of the United States Geological Survey was carried forward much more actively than at any previous time. In California Mr. Ralph Arnold, assisted by Mr. Robert Anderson, extended the general investigations which they have had in progress to the Coalinga field. In Wyoming Messrs. C. W. Washburne and Deane Winchester investigated the occurrence of oil and natural gas in the Bighorn field. Mr. H. S. Gale examined the geology of the Rangely oil field in Colorado. Mr. G. B. Richardson investigated the new occurrence of oil in Virgin City, Utah. In connection with cooperative work with the State Survey of Pennsylvania, Mr. M. J. Munn studied the Clarion quadrangle, Clarion County, also the Carnegie and Sewickley quadrangles, and Mr. Charles Butts studied the oil fields of the Warren quadrangle, Pennsylvania.

As the result in part of the field work of recent years, the United States Geological Survey has published the following bulletins bearing on the oil areas of the country:

*Bulletins bearing on the oil fields of the United States, published by the United States Geological Survey, 1904-1908.*

238. Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, Erasmus Haworth, and W. R. Crane. 1904.
250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 1905.
256. Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone. 1905.
265. Geology of the Boulder district, Colorado, by N. M. Fenneman. 1905.
279. Mineral resources of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. 1906.
282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 1906.
286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey. 1906.
296. Economic geology of the Independence quadrangle, Kansas, by F. G. Schrader and Erasmus Haworth. 1907.
300. Economic geology of the Amity quadrangle in Eastern Washington County, Pa., by F. G. Clapp. 1907.
304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 1907.
309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 1907.
317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907.
318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 1907.
321. Geology and Oil Resources of Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 1907.
322. Geology, Oil Resources of Santa Maria Oil District, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907.

340-F. Investigations relating to petroleum and natural gas in 1907, by Ralph Arnold, G. B. Richardson, C. W. Washburne, and A. R. Schultz. 1908.

346. Structure of the Berea oil sand in the Flushing quadrangle, by W. T. Griswold. 1908.
350. Geology of the Rangely oil district, Colorado, by H. S. Gale. 1908.
357. Geology and oil resources of the Coalinga oil district, Fresno and Kings counties, Cal., by Ralph Arnold and Robert Anderson. [Preliminary report.]

Preliminary announcement of the results obtained in the field examinations of 1907 are contained in Bulletin 340, and the portions referring to oil have been published as Section F, which contains the following chapters: Miner ranch oil field, Contra Costa County, Cal., by Ralph Arnold; Petroleum in southern Utah, by G. B. Richardson; Gas fields of the Bighorn basin, Wyoming, by C. W. Washburne; Labarge oil field, central Uinta County, Wyo., by A. R. Schultz.

During the field season of 1908 the following investigations in the oil regions will be carried on. Mr. Ralph Arnold will continue the investigation of the California oil fields. Messrs. J. A. Taff and W. J. Reed will begin comprehensive studies of the Mid-Continent field. Mr. G. H. Ashley, with Mr. M. J. Munn, will include an examination of the conditions of occurrence of oil in studying the Foxburg quadrangle, Pennsylvania. Mr. A. C. Veatch will make a preliminary examination of the oil pools at Belle Isle and of the Caddo field in Louisiana. In Colorado Mr. C. W. Washburne will, in mapping the coals of the Florence field, examine the conditions of occurrence of oil in that locality, and Mr. George C. Martin will do similar work in the Boulder field.

## PRODUCTION BY FIELDS.

In the following tables the production is grouped by the oil fields described above. They show also the comparative value of each kind of oil and give a summary statement of the activity in oil-well drilling in 1907. It is interesting to note the reverse of activity in the Lima-Indiana field, where 4,580 wells were not only abandoned, but in the majority of cases the casings were pulled out for transfer to Illinois and other productive fields.

*Production of petroleum in the United States, 1902–1907, by fields, in barrels.*

| Field. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| Appalachian | 32,018,787 | 31,558,248 | 31,408,567 | 29,366,960 | 27,741,472 | 25,342,137 |
| Lima-Indiana | 23,358,826 | 24,080,264 | 24,689,184 | 22,294,171 | 17,554,661 | 13,121,094 |
| Illinois | 200 | .......... | .......... | 181,084 | 4,397,050 | 24,281,973 |
| Mid-Continent | 986,720 | 1,573,085 | 6,186,629 | 12,535,777 | 22,838,553 | 46,846,267 |
| Gulf | 18,014,404 | 18,371,383 | 24,631,269 | 36,526,323 | 20,527,520 | 16,410,299 |
| California | 13,984,268 | 24,382,472 | 29,649,434 | 33,427,473 | 33,098,598 | 39,748,375 |
| Other | 403,911 | 495,885 | 515,877 | 385,792 | 336,082 | 345,190 |
| **Total** | 88,766,916 | 100,461,337 | 117,080,960 | 134,717,580 | 126,493,936 | 166,095,335 |

*Percentages of total crude petroleum produced in the several fields, 1902–1907.*

| Field | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| Appalachian | 36.07 | 31.41 | 26.83 | 21.80 | 21.93 | 15.26 |
| Lima-Indiana | 26.31 | 23.97 | 21.09 | 16.55 | 13.88 | 7.90 |
| Illinois | .......... | .......... | .......... | .14 | 3.47 | 14.62 |
| Mid-Continent | 1.12 | 1.57 | 5.28 | .30 | 18.05 | 28.20 |
| Gulf | 20.29 | 18.29 | 21.03 | 27.11 | 16.23 | 9.88 |
| California | 15.75 | 24.27 | 25.33 | 24.81 | 26.17 | 23.93 |
| Other | .46 | .49 | .44 | .29 | .27 | .21 |
| **Total** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

*Production of petroleum in the United States in 1906 and 1907, by fields, showing increase or decrease, in barrels.*

| Field. | 1906. | 1907. | Increase. | Decrease. | Percentage. | |
|---|---|---|---|---|---|---|
| | | | | | Increase. | Decrease. |
| Appalachian | 27,741,472 | 25,342,137 | .......... | 2,399,335 | .......... | 8.65 |
| Lima-Indiana | 17,554,661 | 13,121,094 | .......... | 4,433,567 | .......... | 25.26 |
| Illinois | 4,397,050 | 24,281,973 | 19,884,923 | .......... | 452.23 | .......... |
| Mid-Continent | 22,838,553 | 46,846,267 | 24,009,714 | .......... | 105.14 | .......... |
| Gulf | 20,527,520 | 16,410,299 | .......... | 4,117,221 | .......... | 20.05 |
| California | 33,098,598 | 39,748,375 | 6,649,777 | .......... | 20.09 | .......... |
| Other | 336,082 | 345,190 | 9,108 | .......... | 2.71 | .......... |
| **Total** | 126,493,936 | 166,095,335 | 39,601,399 | .......... | 31.307 | .......... |

*Quantity, total value, and price per barrel received at wells for crude petroleum produced in the United States in 1906 and 1907, by fields.*

| Field. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity, in barrels. | Value. | Price per barrel. | Quantity, in barrels. | Value. | Price per barrel. |
| Appalachian | 27,741,472 | $43,633,601 | $1.573 | 25,342,137 | $43,766,686 | $1.727 |
| Lima-Indiana | 17,554,661 | 15,927,707 | .907 | 13,121,094 | 11,962,410 | .912 |
| Illinois | 4,397,050 | 3,274,818 | .745 | 24,281,973 | 16,432,947 | .677 |
| Mid-Continent | 22,838,553 | 10,358,740 | .453 | 46,846,267 | 19,200,235 | .4098 |
| Gulf | 20,527,520 | 9,382,874 | .457 | 16,410,299 | 13,743,319 | .837 |
| California | 33,098,598 | 9,553,430 | .289 | 39,748,375 | 14,699,956 | .3698 |
| Other | 336,082 | 313,565 | .933 | 345,190 | 301,196 | .8725+ |
| **Total** | 126,493,936 | 92,444,735 | .731 | 166,095,335 | 120,106,749 | .723 |

*Deliveries of crude petroleum in the United States and purposes for which shipped in 1907, by fields, in barrels.*[a]

| Field. | Total shipments in 1907. | Delivered for— | | |
|---|---|---|---|---|
| | | Refining. | Fuel. | Other purposes. |
| Appalachian | 51,909,464 | 51,863,559 | ............ | [b] 45,905 |
| Lima-Indiana | 17,317,051 | 17,307,618 | 9,433 | ............ |
| Illinois | 11,143,563 | 10,926,131 | 217,432 | ............ |
| Kansas and Oklahoma | 28,542,475 | 28,089,424 | 453,051 | ............ |
| Louisiana | 5,902,861 | 119,247 | 5,741,364 | [b] 42,250 |
| Texas | 17,091,804 | 7,548,080 | 9,542,575 | 1,149 |
| California [c] | 39,748,375 | [d] 20,663,779 | [e]19,084,596 | ............ |
| Other | 358,430 | 352,271 | 4,659 | 1,500 |
| Total | 172,014,023 | 136,870,109 | 35,053,110 | 90,804 |

[a] Because of the difficulty of accurate separation the figures in this table and in several following tables are given by fields and States instead of by fields alone.
[b] Lubricating.
[c] About one-third of shipments was consumed by railroads in this State in 1907, and a total of 2,400,000 barrels was used in making gas.
[d] Part of this used for gas making.
[e] Part of this used for roads.

## STOCKS.

Great effort was made to take care of the rapid increase in the newer fields, but the transportation facilities were not equal to the development. Stocks therefore increased from 47,775,376 barrels in 1906 to the unprecedented total of 71,971,941 barrels in 1907. To take care of this stock, it was necessary for the transportation and refining interests to buy the tanks of producers, in addition to building all additional tanks possible. In considering production and stocks, this report does not include the quantities in private producers' storage which have not been measured or turned over to transportation companies. The greatest quantity of this oil is in the Mid-Continent field, and is estimated at 6,650,000 barrels.

*Stocks, runs, and shipments of crude petroleum in the United States in 1907, by fields, in barrels.*

| Field. | Gross stocks Dec. 31, 1906. | Runs from wells sold in 1907. | Shipments in 1907. | Gross stocks Dec. 31, 1907. |
|---|---|---|---|---|
| Appalachian | 8,119,007 | 25,342,137 | 51,909,464 | 6,528,103 |
| Lima-Indiana | [a] 6,793,692 | 13,121,094 | 17,317,051 | 6,700,526 |
| Illinois | 1,899,684 | 24,281,973 | 11,143,563 | 15,848,035 |
| Oklahoma and Kansas | 22,941,034 | 45,933,649 | 28,542,475 | [b] 38,605,538 |
| Louisiana | 1,214,098 | 5,000,221 | 5,902,861 | [c] 391,997 |
| Texas | 4,558 058 | 12,322,696 | 17,091,804 | [c] 2,141,897 |
| California | [d] 2,235.563 | [e] 39,748,375 | 39,748,375 | [f] 1,754,845 |
| Other | 14,240 | 345,190 | 358,430 | 1,000 |
| Total | 47,775,376 | 166,095,335 | 172,014,023 | 71,971,941 |

[a] Includes some stock in the Appalachian field which can not be separated.
[b] In addition it is estimated that 6,650,000 barrels were held in producers' storage and refiners' reserve.
[c] In addition it is estimated that 1,200,000 barrels were held in producers' storage and refiners' reserve.
[d] Field stocks held by producers do not include stocks held by pipe-line companies, which amounted to not less than 4,000,000 barrels.
[e] These figures show quantity of crude run from wells and tanks and sold, and do not represent actual production.
[f] Field stocks held by producers only.

## WELL RECORD.

The following table gives the well record in the United States for 1907, by fields:

*Well record in the United States in 1907, by fields.*

| Field. | Total wells Dec. 31, 1906. | Wells drilled. | | | | Wells abandoned in 1907. | Total wells Dec. 31, 1907. |
|---|---|---|---|---|---|---|---|
| | | Oil. | Gas. | Dry. | Total. | | |
| Appalachian [a] | ........ | 5,209 | ........ | 1,936 | 7,205 | ........ | 5,209 |
| Lima-Indiana [b] | 35,953 | 1,300 | ........ | 264 | 1,564 | 4,580 | 32,673 |
| Illinois [b] | 2,810 | 4,254 | ........ | 685 | 4,939 | 84 | 6,980 |
| Kansas and Oklahoma [a] | ........ | 3,558 | 417 | 408 | 4,383 | ........ | 3,975 |
| Louisiana | ........ | 64 | 11 | 34 | 109 | 55 | 20 |
| Texas | ........ | 769 | 20 | 275 | 1,064 | 279 | 510 |
| California | 2,916 | 296 | 2 | 11 | 309 | 62 | 3,152 |
| Colorado | 51 | 8 | ........ | 12 | 20 | 4 | 55 |
| Other [c] | 44 | 8 | ........ | ........ | 8 | ........ | 52 |
| Total | 41,774 | 15,526 | 450 | 3,625 | 19,601 | 5,064 | 52,686 |

[a] Figures from Oil City Derrick.
[b] Figures partly from Oil City Derrick.
[c] States of Michigan, Missouri, Wyoming, and Utah.

## APPALACHIAN OIL FIELD.

*Geology.*—The geological conditions governing the accumulation of petroleum in this field have been described repeatedly in previous volumes of this series. During the last few years several pools within the field have been studied in detail in the course of geologic mapping by the United States Geological Survey. This work is being continued, especially in Pennsylvania, in cooperation with that State. Among the bulletins containing the results of this work are: No. 256. Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone, 1905; No. 279. Mineral resources of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts, 1906; No. 286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey, 1906; No. 300. Economic geology of the Amity quadrangle in eastern Washington County, Pennsylvania, by F. G. Clapp, 1907; No. 304. Oil and gas fields of Greene County, Pennsylvania, by R. W. Stone and F. G. Clapp, 1907; and No. 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn, 1907.

*Character of the oils.*—In general the oil is "Pennsylvania" grade and commands a higher price than any other. In certain districts such as Tiona and Middle, the quality commands a slight premium and this is true of certain natural lubricating oils produced in very small quantity at Franklin, Pa., and in West Virginia. On the other hand, the Kentucky and Tennessee oils are below Pennsylvania grade and bring a correspondingly lower price. In addition to their freedom from sulphur and asphalt the Appalachian oils have been usually found to consist, to greater extent than any others known, of members of the paraffin or marsh-gas series of oils, and while further analytical work is needed to determine whether this is entirely true, there is no doubt that these oils yield the largest proportion of gasoline and illuminating oils and also are most easily refined by acid treatment.

## PRODUCTION OF THE APPALACHIAN FIELD.

The following tables show the course of the Appalachian oil production since the oil industry began. For the year 1907 details are given showing the production of each month in each State, as obtained from the statements of the pipe-line companies:

*Production of the Appalachian oil field by States and months in 1907, in barrels.*

| Month. | Pennsylvania. | New York. | Ohio. | West Virginia. | Kentucky and Tennessee. | Total. |
|---|---|---|---|---|---|---|
| January | 824,081 | 100,887 | 375,602 | 687,251 | 77,034 | 2,064,855 |
| February | 742,149 | 89,502 | 343,268 | 695,616 | 67,939 | 1,938,474 |
| March | 874,478 | 105,662 | 355,700 | 771,814 | 78,438 | 2,186,092 |
| April | 847,748 | 102,975 | 375,054 | 770,274 | 73,467 | 2,169,518 |
| May | 875,529 | 107,406 | 377,593 | 821,554 | 72,728 | 2,254,810 |
| June | 826,192 | 98,809 | 346,193 | 747,071 | 64,120 | 2,082,385 |
| July | 900,025 | 106,231 | 360,287 | 812,437 | 66,940 | 2,245,920 |
| August | 842,609 | 102,093 | 358,773 | 785,620 | 66,131 | 2,155,226 |
| September | 799,053 | 98,236 | 323,723 | 734,077 | 66,493 | 2,021,582 |
| October | 852,446 | 103,308 | 351,622 | 765,671 | 65,142 | 2,138,189 |
| November | 779,009 | 96,772 | 313,676 | 696,694 | 60,860 | 1,947,011 |
| December | 835,987 | 100,419 | 332,900 | 807,217 | 61,552 | 2,138,075 |
| Total | 9,999,306 | 1,212,300 | 4,214,391 | 9,095,296 | 820,844 | 25,342,137 |

The tables following show the relation of this pioneer oil field to the total production in the United States. They show also the proportion furnished by each State for the last eight years, and fluctuations in the value of the total product for the last three years.

It is evident that, while the great increase from other fields makes the Appalachian oils show rapid decrease in their percentage of the whole production, the actual rate of decrease in the field is much slower, due to the renewed pumping of old wells as the price has increased.

*Production of petroleum in the Appalachian field, 1859–1907, in barrels.*

| Year. | Production. | Per cent of total production. | Increase (+) or decrease (−) from previous year. | Yearly average price per barrel. | Year. | Production. | Per cent of total production. | Increase (+) or decrease (−) from previous year. | Yearly average price per barrel. |
|---|---|---|---|---|---|---|---|---|---|
| 1859 | 2,000 | 100 | ........ | ........ | 1884 | 23,956,438 | 98.92 | + 649,662 | $0.83⅜ |
| 1860 | 500,000 | 100 | + 498,000 | $9.59 | 1885 | 21,533,785 | 98.51 | −2,422,653 | .87⅞ |
| 1861 | 2,113,609 | 100 | +1,613,609 | .49 | 1886 | 26,549,827 | 94.60 | +5,016,042 | .71¼ |
| 1862 | 3,056,690 | 100 | + 943,081 | 1.05 | 1887 | 22,878,241 | 80.90 | −3,671,586 | .66⅝ |
| 1863 | 2,611,309 | 100 | + 445,381 | 3.15 | 1888 | 16,941,397 | 61.36 | −5,936,844 | .87⅝ |
| 1864 | 2,116,109 | 100 | − 495,200 | 8.06 | 1889 | 22,355,225 | 63.57 | +5,413,828 | .94¼ |
| 1865 | 2,497,700 | 100 | + 381,591 | 6.59 | 1890 | 30,073,307 | 65.63 | +7,718,082 | .86¼ |
| 1866 | 3,597,700 | 100 | +1,100,000 | 3.74 | 1891 | 35,848,777 | 66.03 | +5,775,470 | .67 |
| 1867 | 3,347,300 | 100 | − 250,400 | 2.41 | 1892 | 33,432,377 | 66.19 | −2,416,400 | .55⅝ |
| 1868 | 3,646,117 | 100 | + 298,817 | 3.62½ | 1893 | 31,365,890 | 64.76 | −2,066,487 | .64 |
| 1869 | 4,215,000 | 100 | + 568,883 | 5.63¾ | 1894 | 30,783,424 | 62.38 | − 582,466 | .83⅞ |
| 1870 | 5,260,745 | 100 | +1,045,745 | 3.86 | 1895 | 30,960,639 | 58.54 | + 177,215 | 1.35⅝ |
| 1871 | 5,205,234 | 100 | − 55,511 | 4.34 | 1896 | 33,971,902 | 55.73 | +3,010,263 | 1.17⅞ |
| 1872 | 6,293,194 | 100 | +1,087,960 | 3.64 | 1897 | 35,230,271 | 58.25 | +1,258,369 | .78⅞ |
| 1873 | 9,893,786 | 100 | +3,600,592 | 1.83 | 1898 | 31,717,425 | 57.29 | −3,512,846 | .91¼ |
| 1874 | 10,926,945 | 100 | +1,033,159 | 1.17 | 1899 | 33,068,356 | 57.94 | +1,350,931 | 1.29⅝ |
| 1875 | 8,787,514 | 100 | −2,139,431 | 1.35 | 1900 | 36,295,433 | 57.05 | +3,227,077 | 1.35¼ |
| 1876 | 9,120,669 | 99.87 | + 333,155 | 2.56½ | 1901 | 33,618,171 | 48.45 | −2,677,262 | 1.21 |
| 1877 | 13,337,363 | 99.90 | +4,216,694 | 2.42 | 1902 | 32,018,787 | 36.07 | −1,599,384 | 1.23⅞ |
| 1878 | 15,381,641 | 99.90 | +2,044,278 | 1.19 | 1903 | 31,558,248 | 31.41 | − 460,539 | 1.59 |
| 1879 | 19,894,288 | 99.90 | +4,512,647 | .85⅝ | 1904 | 31,408,567 | 26.83 | − 149,681 | 1.62¾ |
| 1880 | 26,245,571 | 99.85 | +6,351,283 | .94⅞ | 1905 | 29,366,960 | 21.80 | −2,041,607 | 1.39⅜ |
| 1881 | 27,561,376 | 99.64 | +1,315,805 | .85¼ | 1906 | 27,741,472 | 21.93 | −1,625,488 | 1.59⅜ |
| 1882 | 30,221,261 | 99.58 | +2,659,885 | .78⅞ | 1907 | 25,342,137 | 15.26 | −2,399,335 | 1.74⅛ |
| 1883 | 23,306,776 | 99.39 | −6,914,485 | 1.05⅝ | | | | | |

In the following table is given the production of the Appalachian field, by States, from 1900 to 1907, inclusive:

*Production of petroleum in the Appalachian field, 1900–1907, by States, in barrels.*

| Year. | Pennsylvania and New York. | West Virginia. | Southeastern Ohio. | Kentucky and Tennessee. | Total. |
|---|---|---|---|---|---|
| 1900 | 14,559,127 | 16,195,675 | 5,478,372 | 62,259 | 36,295,433 |
| 1901 | 13,831,996 | 14,177,126 | 5,471,790 | 137,259 | 33,618,171 |
| 1902 | 13,183,610 | 13,513,345 | 5,136,501 | 185,331 | 32,018,787 |
| 1903 | 12,518,134 | 12,899,395 | 5,586,433 | 554,286 | 31,558,248 |
| 1904 | 12,239,026 | 12,644,686 | 5,526,571 | 998,284 | 31,408,567 |
| 1905 | 11,554,777 | 11,578,110 | 5,016,736 | 1,217,337 | 29,366,960 |
| 1906 | 11,500,410 | 10,120,935 | 4,906,579 | 1,213,548 | 27,741,472 |
| 1907 | 11,211,606 | 9,095,296 | 4,214,391 | 820,844 | 25,342,137 |

In the following table is shown the production of the Appalachian field, by States, in the years 1906 and 1907, with the increase and decrease for each State and the percentage of increase or decrease as compared with the previous year:

*Production of petroleum in the Appalachian field in 1906 and 1907, by States, showing increase or decrease, in barrels.*

| State. | Production. | | Increase. | Decrease. | Percentage. | |
|---|---|---|---|---|---|---|
| | 1906. | 1907. | | | Increase. | Decrease. |
| **New York** | 1,243,517 | 1,212,300 | ............ | 31,217 | ............ | 2.51 |
| **Pennsylvania** | 10,256,893 | 9,999,306 | ............ | 257,587 | ............ | 2.51 |
| **West Virginia** | 10,120,935 | 9,095,296 | ............ | 1,025,639 | ............ | 10.13 |
| **Southeastern Ohio** | 4,906,579 | 4,214,391 | ............ | 692,188 | ............ | 14.11 |
| **Kentucky and Tennessee** | 1,213,548 | 820,844 | ............ | 392,704 | ............ | 32.36 |
| **Total** | 27,741,472 | 25,342,137 | ............ | 2,399,335 | ............ | 8.65 |

In the following table is given the quantity, value, and price per barrel of the oil produced in the Appalachian field during the years 1906 and 1907, by States:

*Quantity and value at wells of crude petroleum produced in the Appalachian field in 1906 and 1907, by States.*

| State. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity in barrels. | Value. | Price per barrel. | Quantity in barrels. | Value. | Price per barrel. |
| **New York** | 1,243,517 | $1,995,337 | $1.605 | 1,212,300 | $2,127,748 | $1.755 |
| **Pennsylvania** | 10,256,893 | 16,596,943 | 1.618 | 9,999,306 | 17,579,706 | 1.758 |
| **West Virginia** | 10,120,935 | 16,170,293 | 1.598 | 9,095,296 | 15,852,428 | 1.743 |
| **Southeastern Ohio** | 4,906,579 | 7,839,359 | 1.598 | 4,214,391 | 7,344,408 | 1.743 |
| **Kentucky and Tennessee** | 1,213,548 | 1,031,629 | .850 | 820,844 | 862,396 | 1.0506 |
| Total | 27,741,472 | 43,633,601 | 1.573 | 25,342,137 | 43,766,686 | 1.727 |

*Production and value of crude petroleum in the Appalachian field, 1905–1907, in barrels.*

| Year. | Pennsylvania. | | New York. | | Macksburg, Ohio. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 10,437,195 | $14,653,278 | 1,117,582 | $1,557,630 | 5,016,736 | $6,992,885 |
| 1906 | 10,256,893 | 16,596,943 | 1,243,517 | 1,995,377 | 4,906,579 | 7,839,359 |
| 1907 | 9,999,306 | 17,579,706 | 1,212,300 | 2,127,748 | 4,214,391 | 7,344,408 |

| Year. | Kentucky-Tennessee. | | West Virginia. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 1,217,337 | $943,211 | 11,578,110 | $16,132,631 | 29,366,960 | $40,279,635 |
| 1906 | 1,213,548 | 1,031,629 | 10,120,935 | 16,170,293 | 27,741,472 | 43,633,601 |
| 1907 | 820,844 | 862,396 | 9,095,296 | 15,852,428 | 25,342,137 | 43,766,686 |

In the two following tables are given the production of crude petroleum in the Appalachian oil field from 1902 to 1907, the first by months and the second by days.

These tables are valuable in so much as they show what months of each year made the highest average production, and also for the comparison of the average daily records of previous years with the production as reported by the press each day.

*Production of crude petroleum in the Appalachian oil field, 1902–1907, by months and years, in barrels.*

| Month. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| January | 2,614,845 | 2,726,634 | 2,377,630 | 2,368,186 | 2,346,346 | 2,064,855 |
| February | 2,253,491 | 2,353,281 | 2,294,922 | 2,207,650 | 2,070,728 | 1,938,474 |
| March | 2,629,104 | 2,759,807 | 2,719.887 | 2,685,538 | 2,397,601 | 2,186,092 |
| April | 2,664,668 | 2,691,431 | 2,599,224 | 2,445,161 | 2,326,650 | 2,169,518 |
| May | 2,759,717 | 2,681,586 | 2,743,881 | 2,685,829 | 2,473,788 | 2,254,810 |
| June | 2,598,349 | 2,731,722 | 2,700,030 | 2,570,383 | 2,383,010 | 2,082,385 |
| July | 2,825,398 | 2,758,308 | 2,697,037 | 2,434,710 | 2,406,191 | 2,245,920 |
| August | 2,728,825 | 2,628,708 | 2,822,017 | 2,523,737 | 2,437,028 | 2,155,226 |
| September | 2,769,060 | 2,633,513 | 2,668,124 | 2,358,897 | 2,198,899 | 2,021,582 |
| October | 2,860,506 | 2,664,422 | 2,606,321 | 2,376,013 | 2,329,121 | 2,138,189 |
| November | 2,609,453 | 2,374,373 | 2,558,764 | 2,268,847 | 2,180,492 | 1,947,011 |
| December | 2,705,371 | 2,554,463 | 2,620,740 | 2,442,000 | 2,191,618 | 2,138,075 |
| Total | 32,018,787 | 31,558,248 | 31,408,567 | 29,366,960 | 27,741,472 | 25,342,137 |

*Average daily production of crude petroleum in the Appalachian oil field each month, 1902–1907, by months and years, in barrels.*

| Month. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| January | 84,350 | 87,956 | 76,698 | 76,393 | 75,689 | 66,608 |
| February | 80,482 | 84,046 | 79,135 | 78,845 | 73,955 | 69,231 |
| March | 84,810 | 89,026 | 87,738 | 86,630 | 77,342 | 70,519 |
| April | 88,822 | 89,714 | 86,641 | 81,505 | 77,555 | 72,317 |
| May | 89,023 | 86,503 | 88,512 | 86,640 | 79,798 | 72,736 |
| June | 86,612 | 91,057 | 90,001 | 85,679 | 79,434 | 69,413 |
| July | 91,142 | 88,978 | 87,001 | 78,539 | 77,619 | 72,449 |
| August | 88,027 | 84,797 | 91,033 | 81,411 | 78,614 | 69,523 |
| September | 92,302 | 87,784 | 88,937 | 78,630 | 73,297 | 67,386 |
| October | 92,274 | 85,949 | 84,075 | 76,646 | 75,133 | 68,974 |
| November | 86,982 | 79,146 | 85,292 | 75,628 | 72,683 | 64,903 |
| December | 87,270 | 82,402 | 84,540 | 78,774 | 70,697 | 68,970 |
| Average | 87,723 | 86,461 | 85,816 | 80,457 | 76,004 | 69,430 |

## PIPE-LINE STATISTICS IN THE APPALACHIAN FIELD.

The pipe-line runs furnish the simplest data for gaging the relative production month by month, and they are given for 1907 in the following table for the principal lines in this field, together with tables of the pipe-line shipments and of the stocks held by these lines for the same period:

*Pipe-line runs in the Appalachian oil field in 1907, by lines and months, in barrels.*

| Month. | National Transit. | Eureka. | Southwest. | Tidewater. | Producers and Refiners. | Emery. |
|---|---|---|---|---|---|---|
| January | 387,037 | 640,053 | 175,550 | 134,357 | 224,452 | 24,290 |
| February | 344,056 | 648,640 | 159,417 | 119,091 | 212,213 | 23,553 |
| March | 408,966 | 717,311 | 179,386 | 144,362 | 248,154 | 26,541 |
| April | 397,933 | 715,195 | 179,982 | 138,008 | 250,878 | 26,059 |
| May | 409,915 | 764,774 | 185,975 | 139,317 | 246,668 | 26,520 |
| June | 378,780 | 695,648 | 169,784 | 136,359 | 222,240 | 25,669 |
| July | 409,485 | 760,653 | 208,770 | 139,690 | 226,169 | 26,265 |
| August | 383,420 | 728,455 | 178,203 | 134,975 | 233,200 | 25,685 |
| September | 366,991 | 683,467 | 166,349 | 130,128 | 203,302 | 24,612 |
| October | 393,967 | 708,202 | 174,987 | 134,024 | 216,393 | 26,609 |
| November | 357,034 | 644,699 | 154,431 | 128,786 | 194,498 | 25,096 |
| December | 381,639 | 751,138 | 169,363 | 135,857 | 206,511 | 26,622 |
| Total | 4,619,223 | 8,458,235 | 2,102,197 | 1,614,954 | 2,684,678 | 307,521 |

| Month. | Cumberland. | Buckeye Macksburg. | New York Transit. | Other pipe lines. | Franklin. | Total. |
|---|---|---|---|---|---|---|
| January | 70,757 | 256,198 | 25,569 | 124,117 | 2,475 | 2,064,855 |
| February | 63,010 | 230,478 | 21,890 | 114,400 | 1,726 | 1,938,474 |
| March | 74,058 | 229,002 | 25,327 | 128,465 | 4,520 | 2,186,092 |
| April | 69,274 | 240,968 | 24,682 | 122,826 | 3,713 | 2,169,518 |
| May | 67,939 | 251,781 | 26,388 | 131,374 | 4,159 | 2,254,810 |
| June | 58,757 | 240,408 | 23,339 | 127,834 | 3,567 | 2,082,385 |
| July | 62,048 | 252,319 | 24,798 | 131,542 | 4,181 | 2,245,920 |
| August | 60,592 | 250,142 | 24,542 | 132,790 | 3,222 | 2,155,226 |
| September | 61,745 | 231,242 | 22,871 | 127,186 | 3,689 | 2,021,582 |
| October | 61,270 | 249,738 | 25,086 | 144,976 | 2,937 | 2,138,189 |
| November | 57,075 | 222,836 | 21,813 | 136,644 | 4,099 | 1,947,011 |
| December | 57,498 | 238,991 | 23,201 | 143,458 | 3,797 | 2,138,075 |
| Total | 764,023 | 2,894,103 | 289,506 | 1,565,612 | 42,085 | 25,342,137 |

*Pipe-line shipments in the Appalachian oil field in 1907, by lines and months, in barrels.*

| Month. | National Transit. | Eureka. | Southwest. | Tidewater. | Producers and Refiners. | Emery. | New York Transit. |
|---|---|---|---|---|---|---|---|
| January | 1,224,397 | 84,001 | 70,379 | 251,988 | 244,516 | 25,332 | 1,297,141 |
| February | 1,115,257 | 42,709 | 63,771 | 226,682 | 219,534 | 18,897 | 1,257,547 |
| March | 1,057,678 | 71,597 | 62,316 | 252,243 | 223,879 | 24,667 | 1,417,091 |
| April | 1,104,065 | 90,716 | 78,357 | 252,101 | 228,780 | 27,981 | 1,532,555 |
| May | 1,248,789 | 93,244 | 74,473 | 255,124 | 227,429 | 29,907 | 1,774,952 |
| June | 1,147,269 | 74,575 | 65,847 | 231,390 | 226,652 | 25,229 | 1,518,540 |
| July | 1,406,342 | 76,377 | 67,168 | 201,789 | 228,247 | 26,903 | 1,523,783 |
| August | 1,600,144 | 79,332 | 72,570 | 185,761 | 203,227 | 25,604 | 1,527,702 |
| September | 1,724,993 | 66,265 | 67,400 | 167,245 | 229,830 | 26,851 | 1,454,605 |
| October | 1,624,968 | 68,108 | 67,305 | 260,656 | 249,890 | 25,079 | 1,444,148 |
| November | 1,573,037 | 93,486 | 62,640 | 238,990 | 225,907 | 24,810 | 1,334,841 |
| December | 1,563,364 | 101,133 | 67,028 | 229,767 | 220,360 | 28,082 | 1,462,707 |
| Total | 16,390,303 | 941,543 | 819,254 | 2,753,736 | 2,728,251 | 309,342 | 17,545,612 |

| Month. | Cumberland. | Southern. | Crescent. | Buckeye Macksburg. | Franklin. | Other pipe lines.[a] | Total. |
|---|---|---|---|---|---|---|---|
| January | 36,571 | 583,054 | 155,450 | ........ | 10,898 | 129,793 | 4,113,520 |
| February | 30,859 | 480,335 | 151,842 | 6,080 | 7,429 | 129,793 | 3,750,735 |
| March | 24,995 | 464,971 | 162,214 | 3,568 | ........ | 129,793 | 3,895,012 |
| April | 23,479 | 476,057 | 134,538 | 4,150 | ........ | 129,793 | 4,082,572 |
| May | 33,958 | 572,411 | 166,829 | 2,432 | ........ | 129,793 | 4,609,341 |
| June | 20,009 | 533,005 | 138,146 | 3,293 | ........ | 129,793 | 4,113,748 |
| July | 26,898 | 628,620 | 158,615 | 4,804 | 124 | 129,793 | 4,479,463 |
| August | 16,997 | 662,513 | 152,199 | 4,802 | 4,521 | 129,793 | 4,665,165 |
| September | 5,641 | 552,013 | 151,349 | 5,841 | ........ | 129,793 | 4,581,826 |
| October | 6,709 | 632,244 | 171,664 | 6,081 | 170 | 129,793 | 4,686,815 |
| November | 5,916 | 561,956 | 138,999 | 1,475 | 8,126 | 129,793 | 4,399,976 |
| December | 12,664 | 562,203 | 142,181 | 2,926 | 9,087 | 129,789 | 4,531,291 |
| Total | 244,696 | 6,709,382 | 1,824,026 | 45,452 | 40,355 | 1,557,512 | 51,909,464 |

[a] Averaged.

*Gross stocks held by pipe lines in the Appalachian oil field at close of each month in 1907, in barrels.*

| Month. | National Transit. | Eureka. | Southwest. | Producers and Refiners. | Emery. | New York Transit. | Cumberland. |
|---|---|---|---|---|---|---|---|
| January | 1,122,122 | 934,150 | 451,420 | 285,158 | 13,437 | 2,063,833 | 139,586 |
| February | 1,085,844 | 1,007,381 | 474,779 | 277,837 | 18,092 | 1,949,519 | 110,578 |
| March | 1,154,420 | 1,157,255 | 575,163 | 302,111 | 19,966 | 1,909,560 | 107,890 |
| April | 1,116,690 | 1,174,463 | 533,917 | 324,208 | 18,044 | 1,603,976 | 139,907 |
| May | 1,129,894 | 1,279,796 | 564,123 | 343,448 | 14,658 | 1,298,577 | 121,464 |
| June | 1,145,521 | 1,200,786 | 532,284 | 339,036 | 15,098 | 1,269,546 | 126,137 |
| July | 1,171,312 | 1,330,146 | 599,513 | 336,959 | 14,459 | 1,191,525 | 99,813 |
| August | 1,186,308 | 1,295,427 | 617,293 | 366,932 | 14,540 | 1,071,020 | 142,458 |
| September | 1,062,307 | 1,317,410 | 825,330 | 340,403 | 12,302 | 1,170,145 | 119,584 |
| October | 1,119,436 | 1,258,151 | 811,076 | 306,906 | 13,831 | 1,139,301 | 125,878 |
| November | 990,309 | 1,263,385 | 743,576 | 275,497 | 14,117 | 985,637 | 129,308 |
| December | 1,061,333 | 1,125,515 | 931,448 | 269,616 | 4,253 | 901,136 | 113,610 |

| Month. | Southern. | Crescent. | Northern. | United States. | Buckeye Macksburg. | Franklin. | Other lines. | Total. |
|---|---|---|---|---|---|---|---|---|
| January | 413,005 | 95,402 | 1,625,979 | 77,502 | ........ | 24,739 | ........ | ........ |
| February | 376,746 | 77,226 | 1,572,415 | 81,035 | 298,954 | 19,306 | ........ | ........ |
| March | 364,670 | 64,615 | 1,457,351 | 83,395 | 283,912 | 23,235 | ........ | ........ |
| April | 467,991 | 77,742 | 1,419,225 | 88,366 | 297,010 | 26,327 | ........ | ........ |
| May | 365,068 | 62,692 | 1,219,157 | 85,522 | 277,682 | 29,954 | ........ | ........ |
| June | 581,639 | 74,754 | 1,031,856 | 89,035 | 286,764 | 32,883 | ........ | ........ |
| July | 726,890 | 74,846 | 993,833 | 75,355 | 279,549 | 36,508 | ........ | ........ |
| August | 721,225 | 82,250 | 981,960 | 67,021 | 278,943 | 34,612 | ........ | ........ |
| September | 593,672 | 80,034 | 740,876 | 53,833 | 241,631 | 37,788 | ........ | ........ |
| October | 517,779 | 61,548 | 733,525 | 62,559 | 248,476 | 40,277 | ........ | ........ |
| November | 526,426 | 59,552 | 738,884 | 68,557 | 228,097 | 35,794 | ........ | ........ |
| December | 473,974 | 65,308 | 698,478 | 72,295 | 227,394 | 36,425 | 547,318 | 6,528,103 |

## PRICES OF APPALACHIAN OIL.

The Seep Purchasing Agency publishes each day the price it is willing to pay for each grade of oil. The significant price is that for "Pennsylvania" grade, as this covers by far the greater part of the Appalachian product. The course of prices is shown below. The fluctuations in price have frequently produced higher maximum prices, but the minimum price remained higher in 1907 than in any year since 1872.

*Range of prices paid by the Seep Purchasing Agency for light crude petroleum produced in the New York, Ohio, Pennsylvania, and West Virginia oil regions during 1906 and 1907, per barrel of 42 gallons.*

| | Tiona, Pa. | Pennsylvania. | Second sand, Pa. | Corning, Ohio. | Newcastle, Ohio. | Butler and Richland. | Cabell, W. Va. |
|---|---|---|---|---|---|---|---|
| 1906. | | | | | | | |
| January 1 | $1.68 | $1.58 | $1.58 | $1.10 | $1.35 | $1.78 | $1.18 |
| April 13 | 1.71 | 1.61 | 1.61 | 1.13 | 1.38 | 1.81 | 1.21 |
| April 25 | 1.74 | 1.64 | 1.64 | 1.16 | 1.41 | 1.84 | 1.24 |
| July 28 | 1.71 | 1.61 | 1.61 | 1.13 | 1.38 | 1.81 | 1.21 |
| August 2 | 1.68 | 1.58 | 1.58 | 1.10 | 1.35 | 1.78 | 1.18 |
| 1907. | | | | | | | |
| January 1 | 1.68 | 1.58 | 1.58 | 1.10 | 1.35 | 1.78 | 1.18 |
| February 11 | 1.73 | 1.63 | 1.63 | 1.12 | 1.37 | 1.78 | 1.20 |
| March 9 | 1.78 | 1.68 | 1.68 | 1.14 | 1.39 | 1.78 | 1.22 |
| March 13 | 1.78 | 1.78 | 1.78 | 1.14 | 1.39 | 1.78 | 1.22 |
| April 12 | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.78 | 1.22 |
| June 1 | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.78 | 1.32 |

In the following table is given the average price per month of the different light oils of New York, Pennsylvania, Ohio, and West Virginia during the years 1906 and 1907:

*Average monthly prices of Appalachian crude petroleum in 1906 and 1907, per barrel.*

| Month. | Tiona, Pa. | Pennsylvania. | Butler and Richland. | Corning, Ohio. | Newcastle, Ohio. | Cabell, W. Va. |
|---|---|---|---|---|---|---|
| 1906. | | | | | | |
| January | $1.68 | $1.58 | $1.78 | $1.10 | $1.35 | $1.18 |
| February | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| March | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| April | 1.70⅜ | 1.60⅜ | 1.80⅜ | 1.12⅜ | 1.37⅜ | 1.20⅜ |
| May | 1.74 | 1.64 | 1.84 | 1.16 | 1.41 | 1.24 |
| June | 1.74 | 1.64 | 1.84 | 1.16 | 1.41 | 1.24 |
| July | 1.73⅝ | 1.63⅝ | 1.83⅝ | 1.15⅝ | 1.40⅝ | 1.23⅝ |
| August | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| September | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| October | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| November | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| December | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| Average | 1.69⅔ | 1.59⅔ | 1.79⅔ | 1.11⅔ | 1.36⅔ | 1.19⅔ |
| 1907. | | | | | | |
| January | 1.68 | 1.58 | 1.78 | 1.10 | 1.35 | 1.18 |
| February | 1.71¼ | 1.61¼ | 1.78 | 1.11¼ | 1.36¼ | 1.19¼ |
| March | 1.76¾ | 1.72⅞ | 1.78 | 1.13½ | 1.38½ | 1.21½ |
| April | 1.78 | 1.78 | 1.78 | 1.14 | 1.28¼ | 1.22 |
| May | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.22 |
| June | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| July | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| August | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| September | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| October | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| November | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| December | 1.78 | 1.78 | 1.78 | 1.14 | 1.22 | 1.32 |
| Average | 1.76½ | 1.74½ | 1.78 | 1.13⅜ | 1.26¼ | 1.27¼ |

The average monthly and yearly prices per barrel of the crude petroleum in the Appalachian field for the years 1902–1907 are given in the following table:

*Monthly and yearly average prices of pipe-line certificates of Pennsylvania crude petroleum at wells in daily market, 1902–1907, per barrel.*

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1902 | $1.15 | $1.15 | $1.15 | $1.17½ | $1.20 | $1.20⅜ | $1.22 | $1.22 | $1.22 | $1.28¼ | $1.38¼ | $1.49 | $1.23¾ |
| 1903 | 1.52½ | 1.50 | 1.50 | 1.51 | 1.51½ | 1.50 | 1.52½ | 1.56 | 1.57½ | 1.68½ | 1.78⅜ | 1.88⅜ | 1.59 |
| 1904 | 1.85 | 1.82 | 1.72⅜ | 1.65⅛ | 1.62 | 1.58⅜ | 1.52 | 1.50 | 1.53¾ | 1.56 | 1.58⅜ | 1.57 | 1.62⅞ |
| 1905 | 1.43⅛ | 1.39 | 1.38¼ | 1.32⅞ | 1.28⅜ | 1.27 | 1.27 | 1.27 | 1.35⅜ | 1.57½ | 1.59 | 1.58 | 1.39⅞ |
| 1906 | 1.58 | 1.58 | 1.58 | 1.60⅜ | 1.64 | 1.64 | 1.63⅜ | 1.58 | 1.58 | 1.58 | 1.58 | 1.58 | 1.59⅜ |
| 1907 | 1.58 | 1.61¼ | 1.72⅞ | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.78 | 1.74½ |

The following table shows the range of prices of Pennsylvania crude oil each year since 1859:

*Highest and lowest prices of Pennsylvania crude petroleum each year, 1859–1907, per barrel.*

| Year. | Highest. | | Lowest. | |
|---|---|---|---|---|
| | Month. | Price. | Month. | Price. |
| 1859 | September | $20.00 | December | $20.00 |
| 1860 | January | 20.00 | December | 2.00 |
| 1861 | January | 1.75 | December | .10 |
| 1862 | December | 2.50 | January | .10 |
| 1863 | December | 4.00 | January | 2.00 |
| 1864 | July | 14.00 | February | 3.75 |
| 1865 | January | 10.00 | August | 4.00 |
| 1866 | January | 5.50 | December | 1.35 |
| 1867 | October | 4.00 | June | 1.50 |
| 1868 | July | 5.75 | January | 1.70 |
| 1869 | January | 7.00 | December | 4.25 |
| 1870 | January | 4.90 | August | 2.75 |
| 1871 | June | 5.25 | January | 3.25 |
| 1872 | October | 4.55 | December | 2.67½ |
| 1873 | January | 2.75 | November | .82½ |
| 1874 | February | 2.25 | November | .62½ |
| 1875 | February | 1.82½ | January | .75 |
| 1876 | December | 4.23¾ | January | 1.47½ |
| 1877 | January | 3.69⅜ | June | 1.53⅜ |
| 1878 | February | 1.87¼ | September | .78⅜ |
| 1879 | December | 1.28⅛ | June | .63⅞ |
| 1880 | June | 1.24⅞ | April | .71⅛ |
| 1881 | September | 1.01¼ | July | .72⅝ |
| 1882 | November | 1.37 | July | .49⅜ |
| 1883 | June | 1.24⅜ | January | .83¼ |
| 1884 | January | 1.15⅜ | June | .51¼ |
| 1885 | October | 1.12⅞ | January | .68 |
| 1886 | January | .92¼ | August | .59⅞ |
| 1887 | December | .90 | July | .54 |
| 1888 | March | 1.00 | June | .71⅞ |
| 1889 | November | 1.12¼ | April | .79⅝ |
| 1890 | January | 1.07⅞ | December | .60⅜ |
| 1891 | February | .81⅞ | August | .50 |
| 1892 | January | .64¼ | October | .50 |
| 1893 | December | .80 | January | .52⅞ |
| 1894 | December | .95¼ | January | .78⅜ |
| 1895 | April | 2.60 | January | .95¼ |
| 1896 | January | 1.50 | December | .90 |
| 1897 | March | .96 | October | .65 |
| 1898 | December | 1.19 | January | .65 |
| 1899 | December | 1.66 | February | 1.13 |
| 1900 | January | 1.68 | November | 1.05 |
| 1901 | January, September | 1.45 | May | .80 |
| 1902 | December | 1.54 | January, February, March. | 1.15 |
| 1903 | December | 1.90 | January, February, March, April, May, June, July. | 1.50 |
| 1904 | January | 1.85 | July, December | 1.50 |
| 1905 | October | 1.61 | May | 1.27 |
| 1906 | April, May, June, July. | 1.64 | January, February, March, April, August, September, October, November, December. | 1.58 |
| 1907 | March to December, inclusive. | 1.78 | January | 1.58 |

### NEW YORK AND PENNSYLVANIA.

New York's production amounted to 1,212,300 barrels in 1907, a decline of 2.5 per cent from 1,243,517 barrels in 1906. Pennsylvania declined by exactly the same percentage from 10,256,893 barrels in 1906 to 9,999,306 barrels in 1907. These decreases, although slight, are rendered significant by the activity in the effort to develop new territory and by the renewal of work on wells in old territory. A gusher in Greene County was the only encouraging feature, and efforts to duplicate it were fruitless.

### WEST VIRGINIA.

West Virginia showed a decline from 10,120,935 barrels to 9,095,296, or 10.13 per cent, although the efforts to develop new territory were more energetic than in Pennsylvania. The new work in Tyler and Wetzel counties furnished some surprisingly good results. The Congo pool in the former county increased its daily output in the first part of the year, but rapidly declined again. Wetzel County yielded a gusher in September which showed unusual persistence.

#### PRODUCTION.

In the following table is given the production of crude petroleum in West Virginia in 1905, 1906, and 1907, by months:

*Total production of crude petroleum in West Virginia, by months, 1905, 1906, and 1907, in barrels.*

| Month. | 1905. | 1906. | 1907. |
|---|---|---|---|
| January | 940,709 | 832,628 | 687,251 |
| February | 923,632 | 752,399 | 695,616 |
| March | 1,003,107 | 897,277 | 771,814 |
| April | 970,540 | 833,514 | 770,274 |
| May | 1,078,884 | 923,039 | 821,554 |
| June | 1,026,569 | 872,138 | 747,071 |
| July | 952,919 | 917,879 | 812,437 |
| August | 996,356 | 906,522 | 785,620 |
| September | 911,583 | 777,682 | 734,077 |
| October | 901,944 | 833,781 | 765,671 |
| November | 850,791 | 762,915 | 696,604 |
| December | 922,076 | 811,161 | 807,217 |
| Total | 11,578,110 | 10,120,935 | 9,095,296 |

The quantity and value of crude petroleum produced in West Virginia from 1902 to 1907, inclusive, is shown in the following table:

*Quantity and value of crude petroleum produced in West Virginia, 1902–1907.*

| Year. | Regular crude. | | | Lubricating crude. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity (barrels). | Value. | Price per barrel. | Quantity (barrels). | Value. | Price per barrel. | Quantity (barrels). | Value. | Price per barrel. |
| 1902 | 13,498,685 | $17,006,469 | $1.26 | 14,660 | $33,848 | $2.31 | 13,513,345 | $17,040,317 | $1.261 |
| 1903 | 12,893,079 | 20,499,996 | 1.59 | 6,316 | 16,536 | 2.62 | 12,899,395 | 20,516,532 | 1.59 |
| 1904 | 12,636,253 | 20,557,556 | 1.627 | 8,433 | 26,225 | 3.11 | 12,644,686 | 20,583,781 | 1.628 |
| 1905 | 11,573,545 | 16,117,816 | 1.393 | 4,565 | 14,815 | 3.25 | 11,578,110 | 16,132,631 | 1.393 |
| 1906 | 10,111,647 | 16,138,811 | 1.596 | 9,288 | 31,482 | 3.39 | 10,120,935 | 16,170,293 | 1.598 |
| 1907 | 9,089,839 | 15,834,714 | 1.74 | 5,457 | 17,714 | 3.25 | 9,095,296 | 15,852,428 | 1.743 |

## KENTUCKY AND TENNESSEE.

In production, Kentucky and Tennessee showed a decrease from 1,213,548 barrels in 1906 to 820,844 barrels in 1907, the decrease being in line with the general tendency in the Appalachian region. It is just to note, however, that the activity in drilling in the deep sand region in Wolfe County and the conditions in Wayne County, Ky., might justify the expectation of an increase, which was probably only prevented by the fact that the sensational developments in Illinois drew many operators to that new field.

The Indian Refining Company constructed one of the largest independent refineries in the country at Georgetown, Ky. This became an important factor in the development of the oil industry of the State. Another Kentucky refinery is contemplated by the same company; and as the State contains many regions which give promise of petroleum, it is likely that its petroleum resources will be thoroughly tested.

The activity in Wayne County, Ky., extended to adjoining counties in Tennessee, but aside from this no unusual developments took place.

### PRODUCTION.

In the following table is given the production of crude petroleum in Kentucky and Tennessee, by months, in 1905, 1906, and 1907:

*Production of crude petroleum in Kentucky and Tennessee, by months, 1905-1907, in barrels.*

| Month. | 1905. | 1906. | 1907. |
|---|---|---|---|
| January | 77,569 | 115,317 | 77,034 |
| February | 71,355 | 101,084 | 67,939 |
| March | 103,315 | 109,351 | 78,438 |
| April | 100,508 | 103,690 | 73,467 |
| May | 114,702 | 102,224 | 72,728 |
| June | 118,181 | 106,005 | 64,120 |
| July | 117,452 | 106,708 | 66,940 |
| August | 109,562 | 106,936 | 66,131 |
| September | 106,469 | 96,561 | 66,493 |
| October | 101,559 | 94,385 | 65,142 |
| November | 93,817 | 88,483 | 60,860 |
| December | 102,848 | 82,804 | 61,552 |
| Total | 1,217,337 | 1,213,548 | 820,844 |

In the following table are given the dates of change and the changes in prices of the different grades of petroleum produced in Kentucky and Tennessee during the years 1905, 1906, and 1907:

*Fluctuations in prices, per barrel, of Kentucky and Tennessee crude petroleum in 1905, 1906, and 1907.*

| 1905. | | | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|---|---|
| Date. | Whitehouse, Somerset, Lacy, Barboursville (light). | Barboursville (heavy), Ragland. | Date. | Whitehouse, Somerset, Lacy, Barboursville (light). | Barboursville (heavy), Ragland. | Date. | Whitehouse, Somerset, Lacy, Barboursville (light). | Barboursville (heavy), Ragland. |
| January 1 | $0.91 | $0.58 | January 1 | $0.89 | $0.49 | January 1 | $0.85 | $0.55 |
| January 5 | .86 | .58 | April 13 | .89 | .49 | January 5 | .85 | .60 |
| January 11 | .83 | .55 | April 25 | .91 | .62 | February 11 | .87 | .60 |
| January 31 | .80 | .53 | July 28 | .89 | .60 | March 9 | .89 | .62 |
| April 12 | .78 | .51 | August 2 | .87 | .60 | March 20 | 1.04 | .62 |
| April 18 | .77 | .50 | August 28 | .85 | .55 | March 29 | 1.20 | .62 |
| April 25 | .76 | .50 | | | | April 24 | 1.20 | .70 |
| May 27 | .75 | .49 | | | | June 1 | 1.20 | .75 |
| September 12 | .77 | .49 | | | | October 29 | 1.10 | .75 |
| September 16 | .79 | .49 | | | | November 12 | 1.00 | .75 |
| September 19 | .81 | .49 | | | | | | |
| September 28 | .83 | .49 | | | | | | |
| October 13 | .89 | .49 | | | | | | |
| October 20 | .91 | .49 | | | | | | |
| November 11 | .89 | .49 | | | | | | |

In the following table are given the average monthly prices of Kentucky and Tennessee crude petroleum, per barrel of 42 gallons, in the years 1905 to 1907, inclusive:

*Average monthly prices, per barrel, of Kentucky and Tennessee crude petroleum in 1905–1907.*

| Month. | 1905. | 1906. | 1907. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| | Whitehouse, Somerset, Lacy. | Whitehouse, Somerset, Lacy. | Whitehouse, Somerset, Lacy. | Ragland. | Ragland. | Ragland. |
| January | $0.84⅘ | $0.89 | $0.85 | $0.55¾ | $0.49 | $0.59⅞ |
| February | .80 | .89 | .86¼ | .53 | .49 | .60 |
| March | .80 | .89 | .95½ | .53 | .49 | .61½ |
| April | .78 | .89⅘ | 1.20 | .51¼ | .51⅘ | .63¾ |
| May | .75⅘ | .91 | 1.20 | .49⅞ | .62 | .70 |
| June | .75 | .91 | 1.20 | .49 | .62 | .75 |
| July | .75 | .90⅘ | 1.20 | .49 | .61⅘ | .75 |
| August | .75 | .86¼ | 1.20 | .49 | .59¼ | .75 |
| September | .78⅘ | .85 | 1.20 | .49 | .55 | .75 |
| October | .87½ | .85 | 1.18¾ | .49 | .55 | .75 |
| November | .89⅔ | .85 | 1.03⅕ | .49 | .55 | .75 |
| December | .89 | .85 | 1.00 | .49 | .55 | .75 |
| Average | .80⅔ | .88 | 1.09¼ | .50½ | .55½ | .70 |

## OHIO.

Southeastern Ohio embraces a part of the Appalachian field and the northwestern part of the State includes a part of the Lima-Indiana field. The oils are radically different, the latter containing notable percentages of sulphur.

Production in both fields has declined quite regularly in the last few years, the decline for the entire State being 17.45 per cent, or from 14,787,763 barrels in 1906 to 12,207,448 barrels in 1907. More casings were pulled from old wells than were offset by the development of new wells.

### PRODUCTION.

In the following table is given the production of crude petroleum in Ohio, by months and districts, for the year 1907:

*Total production of crude petroleum in Ohio in 1907, by months and districts, in barrels.*

| Month. | Lima. | Southeastern Ohio. | Mecca-Belden. | Total. |
|---|---|---|---|---|
| January | 709,879 | 375,594 | ............ | 1,085,473 |
| February | 656,257 | 343,260 | ............ | 999,517 |
| March | 693,647 | 355,692 | ............ | 1,049,339 |
| April | 700,399 | 375,046 | ............ | 1,075,445 |
| May | 729,178 | 377,585 | ............ | 1,106,763 |
| June | 658,319 | 346,185 | ............ | 1,004,552 |
| July | 694,705 | 360,279 | ............ | 1,054,992 |
| August | 659,780 | 358,765 | ............ | 1,018,553 |
| September | 606,211 | 323,715 | ............ | 929,934 |
| October | 659,323 | 351,614 | ............ | 1,010,945 |
| November | 608,406 | 313,671 | ............ | 922,082 |
| December | 616,953 | 332,892 | ............ | 949,853 |
| Total | 7,993,057 | 4,214,298 | 93 | 12,207,448 |

The total quantity and value of crude petroleum produced in Ohio from 1900 to 1907, inclusive, by districts, are shown in the following table:

*Total quantity and value of crude petroleum produced in Ohio, 1900–1907, in barrels.*

| Year. | Lima district. | | Southeastern Ohio district. | | Mecca-Belden district. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1900 | 16,884,358 | $16,673,304 | 5,476,089 | $7,406,734 | 2,283 | $11,563 | 22,362,730 | $24,091,601 |
| 1901 | 16,176,293 | 13,911,612 | 5,470,850 | 6,619,342 | 940 | 2,617 | 21,648,083 | 20,533,571 |
| 1902 | 15,877,730 | 14,284,072 | 5,136,366 | 6,471,821 | 135 | 1,466 | 21,014,231 | 20,757,359 |
| 1903 | 14,893,853 | 17,351,339 | 5,585,858 | 8,881,514 | 575 | 1,668 | 20,480,286 | 26,234,521 |
| 1904 | 13,350,060 | 14,735,129 | 5,526,146 | 8,993,803 | 425 | 1,583 | 18,876,631 | 23,730,515 |
| 1905 | 11,329,924 | 10,061,992 | 5,016,646 | 6,991,950 | 90 | 935 | 16,346,660 | 17,054,877 |
| 1906 | 9,881,184 | 9,157,641 | 4,906,399 | 7,838,387 | 180 | 972 | 14,787,763 | 16,997,000 |
| 1907 | 7,993,057 | 7,425,480 | 4,214,298 | 7,343,943 | 93 | 465 | 12,207,448 | 14,769,888 |

In the following table are given the production and value of the crude petroleum in the Mecca-Belden district from 1902 to 1907, inclusive:

*Output of crude petroleum in the Mecca-Belden district of Ohio, 1902–1907, in barrels.*

| Year. | Belden district, Lorain County. | | | Mecca district, Trumbull County. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Price per barrel. | Quantity. | Value. | Price per barrel. | Quantity. | Value. | Price per barrel. |
| 1902 | 55 | $193 | $3.50 | 80 | $1,273 | $15.91 | 135 | $1,466 | $10.85 |
| 1903 | 550 | 1,300 | 2.36 | 25 | 368 | 14.70 | 575 | 1,668 | 2.90 |
| 1904 | 362 | 620 | 1.71 | 63 | 963 | 15.28 | 425 | 1,583 | 3.73 |
| 1905 | 40 | 148 | 3.70 | 50 | 787 | 15.74 | 90 | 935 | 10.39 |
| 1906 | 140 | 392 | 2.80 | 40 | 580 | 14.50 | 180 | 972 | 5.40 |
| 1907 | 75 | 188 | 2.50 | 18 | 277 | 15.39 | 93 | 465 | 5.00 |

## LIMA-INDIANA OIL FIELD.

This field, embracing northwestern Ohio and the State of Indiana, obtains its oil from Trenton limestone in which occasional alteration of dolomite limestone has left porosity sufficient for considerable oil accumulations. Sulphur is a characteristic of this as of other limestone oils, but refining processes have been so perfected as to produce from them absolutely satisfactory products of all kinds, including a good yield of paraffin wax. As already indicated, production in this field is on the decline, which was accentuated in 1907 by the new Illinois field on the west, which has attracted many of the operators.

### PRODUCTION OF LIMA-INDIANA FIELD.

In the following table will be found the production of the Lima-Indiana field, by States and months, for the year 1907:

*Production of crude petroleum in the Lima-Indiana oil field in 1907, by months, in barrels.*

| Month. | Lima, Ohio. | Indiana. | Total. |
|---|---|---|---|
| January | 709,879 | 483,994 | 1,193,873 |
| February | 656,257 | 451,111 | 1,107,368 |
| March | 693,647 | 458,119 | 1,151,766 |
| April | 700,399 | 468,057 | 1,168,456 |
| May | 729,178 | 481,895 | 1,211,073 |
| June | 658,319 | 438,428 | 1,096,747 |
| July | 694,705 | 461,912 | 1,156,617 |
| August | 659,780 | 427,877 | 1,087,657 |
| September | 606,211 | 380,269 | 986,480 |
| October | 659,323 | 386,568 | 1,045,891 |
| November | 608,406 | 349,238 | 957,644 |
| December | 616,953 | 340,569 | 957,522 |
| Total | 7,993,057 | 5,128,037 | 13,121,094 |

In the following table will be found the production of the Lima-Indiana field from 1902 to 1907, inclusive, with its percentage of the total production of the United States, the increase or decrease made each year, and the percentage of increase or decrease:

*Production of petroleum in the Lima-Indiana field, 1902–1907.*

| Year. | Production, in barrels. | Percentage of total production. | Increase. | Decrease. | Percentage. |  |
|---|---|---|---|---|---|---|
|  |  |  |  |  | Increase. | Decrease. |
| 1902 | 23,358,826 | 26.31 | 1,425,197 | ............ | 6.50 | ............ |
| 1903 | 24,080,264 | 23.97 | 721,438 | ............ | 3.09 | ............ |
| 1904 | 24,689,184 | 21.09 | 608,920 | ............ | 2.53 | ............ |
| 1905 | 22,294,171 | 16.55 | ............ | 2,395,013 | ............ | 9.7 |
| 1906 | 17,554,661 | 13.88 | ............ | 4,739,510 | ............ | 21.26 |
| 1907 | 13,121,094 | 7.9 | ............ | 4,433,567 | ............ | 25.26 |

*Production and value of crude petroleum in the Lima-Indiana field, 1905–1907, in barrels.*

| Year. | North Lima, Ohio. |  | South Lima, Ohio. |  |
|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. |
| 1905 | 6,931,635 | $6,290,459 | 4,398,289 | $3,771,533 |
| 1906 | 6,859,669 | 6,479,607 | 3,021,515 | 2,678,034 |
| 1907 | 6,399,917 | 6,016,238 | 1,593,140 | 1,409,242 |

| Year. | Indiana. |  | Total. |  |
|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. |
| 1905 | 10,964,247 | $9,404,909 | 22,294,171 | $19,466,901 |
| 1906 | 7,673,477 | 6,770,066 | 17,554,661 | 15,927,707 |
| 1907 | 5,128,037 | 4,536,930 | 13,121,094 | 11,962,410 |

## PIPE-LINE RUNS AND SHIPMENTS AND STOCKS IN LIMA-INDIANA FIELD.

The following tables show the pipe-line runs and shipments and the stocks on hand in the Lima-Indiana field:

*Pipe-line runs in the Lima-Indiana oil field in 1907, by months, in barrels.*

| Month. | Buckeye Pipe Line. | Other Ohio. | Indiana Pipe Line. | Other Indiana. | Total. |
|---|---|---|---|---|---|
| January | 501,644 | 208,235 | 407,362 | 76,632 | 1,193,873 |
| February | 451,083 | 205,174 | 381,699 | 69,412 | 1,107,368 |
| March | 466,604 | 227,043 | 387,608 | 70,511 | 1,151,766 |
| April | 472,830 | 227,569 | 398,716 | 69,341 | 1,168,456 |
| May | 487,998 | 241,180 | 406,660 | 75,235 | 1,211,073 |
| June | 432,128 | 226,191 | 368,443 | 69,985 | 1,096,747 |
| July | 462,462 | 232,243 | 390,475 | 71,437 | 1,156,617 |
| August | 431,836 | 227,944 | 359,769 | 68,108 | 1,087,657 |
| September | 395,486 | 210,725 | 323,656 | 56,613 | 986,480 |
| October | 434,784 | 224,539 | 328,875 | 57,093 | 1,045,891 |
| November | 398,973 | 209,433 | 294,673 | 54,565 | 957,644 |
| December | 400,088 | 216,865 | 288,283 | 52,286 | 957,522 |
| Total | 5,335,916 | 2,657,141 | 4,336,219 | 791,818 | 13,121,094 |

*Pipe-line shipments of crude petroleum in the Lima-Indiana oil field in 1907, by months, in barrels.*

| Month. | Buckeye Pipe Line. | Indiana Pipe Line. | Other lines. | Total. |
|---|---|---|---|---|
| January | 326,931 | 727,117 | 287,694 | 1,341,742 |
| February | 393,797 | 777,559 | 278,149 | 1,449,505 |
| March | 420,541 | 794,973 | 290,162 | 1,505,676 |
| April | 424,446 | 762,220 | 286,395 | 1,473,061 |
| May | 461,122 | 618,040 | 307,918 | 1,387,080 |
| June | 456,643 | 631,137 | 289,692 | 1,377,472 |
| July | 423,706 | 508,393 | 292,019 | 1,224,118 |
| August | 442,971 | 815,270 | 293,559 | 1,551,800 |
| September | 453,822 | 748,863 | 271,944 | 1,474,629 |
| October | 483,961 | 789,031 | 280,025 | 1,553,017 |
| November | 353,042 | 808,497 | 265,472 | 1,427,011 |
| December | 374,128 | 913,312 | 264,500 | 1,551,940 |
| Total | 5,015,110 | 8,894,412 | 3,407,529 | 17,317,051 |

*Gross stocks of crude petroleum in the Lima-Indiana oil field in 1907, by months, in barrels.*

| Month. | Buckeye Pipe Line. | Indiana Pipe Line. | Other. | Total. |
|---|---|---|---|---|
| January | 5,656,616 | 812,727 | | |
| February | 5,110,718 | 963,600 | | |
| March | 5,291,879 | 1,009,220 | | |
| April | 5,020,219 | 1,037,525 | | |
| May | 4,792,016 | 1,223,699 | | |
| June | 4,957,792 | 1,203,062 | | |
| July | 5,257,499 | 1,334,485 | | |
| August | 5,396,040 | 1,088,026 | | |
| September | 5,594,977 | 977,283 | | |
| October | 5,563,549 | 947,020 | | |
| November | 5,719,456 | 875,453 | | |
| December | 5,598,408 | 922,071 | 180,047 | 6,700,526 |

## PRICES OF CRUDE PETROLEUM IN LIMA-INDIANA FIELD.

In the following table are given the fluctuations in prices for the various grades of Lima and Indiana oil in 1905, 1906, and 1907. The dates are those on which changes in prices were made.

*Fluctuations in prices of Lima (Ohio) and Indiana crude petroleum in 1905, 1906, and 1907, per barrel.*

| 1905. | | | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|---|---|
| Date. | North Lima. | South Lima and Indiana. | Date. | North Lima. | South Lima and Indiana. | Date. | North Lima. | South Lima and Indiana. |
| January 1 | $1.01 | $0.96 | January 1 | $0.94 | $0.89 | January 1 | $0.90 | $0.85 |
| January 5 | .98 | .93 | April 13 | .96 | .91 | February 11 | .92 | .87 |
| January 11 | .95 | .90 | April 25 | .98 | .93 | March 9 | .94 | .89 |
| January 31 | .93 | .88 | July 28 | .96 | .91 | | | |
| March 25 | .91 | .86 | August 2 | .94 | .89 | | | |
| April 12 | .89 | .84 | August 15 | .92 | .87 | | | |
| April 18 | .88 | .83 | August 28 | .90 | .85 | | | |
| April 25 | .87 | .82 | | | | | | |
| May 27 | .86 | .81 | | | | | | |
| September 12 | .88 | .83 | | | | | | |
| September 16 | .90 | .85 | | | | | | |
| September 19 | .92 | .87 | | | | | | |
| September 28 | .94 | .89 | | | | | | |
| October 20 | .96 | .91 | | | | | | |
| November 11 | .94 | .89 | | | | | | |

In the following table are given the average monthly prices of Lima (Ohio) and Indiana crude pertoleum, per barrel of 42 gallons each, in the years 1905 to 1907:

*Average monthly prices of Ohio and Indiana crude petroleum in 1905, 1906, and 1907, per barrel.*

| Month. | 1905. | | 1906. | | 1907. | | |
|---|---|---|---|---|---|---|---|
| | North Lima. | South Lima and Indiana. | North Lima. | South Lima and Indiana. | North Lima. | South Lima and Indiana. | Princeton, Ind. |
| January | $0.96¼ | $0.91¼ | $0.94 | $0.89 | $0.90 | $0.85 | $0.64 |
| February | .93 | .88 | .94 | .89 | .91½ | .86½ | .65½ |
| March | .92½ | .87½ | .94 | .89 | .93¼ | .88½ | .67½ |
| April | .89 | .84 | .95⅝ | .90⅝ | .94 | .89 | .68 |
| May | .86⅞ | .81⅞ | .98 | .93 | .94 | .89 | .68 |
| June | .86 | .81 | .98 | .93 | .94 | .89 | .68 |
| July | .86 | .81 | .97⅝ | .92⅝ | .94 | .89 | .68 |
| August | .86 | .81 | .92⅝ | .87⅝ | .94 | .89 | .68 |
| September | .89⅝ | .84⅝ | .90 | .85 | .94 | .89 | .68 |
| October | .94¼ | .89¼ | .90 | .85 | .94 | .89 | .68 |
| November | .94¾ | .89¾ | .90 | .85 | .94 | .89 | .68 |
| December | .94 | .89 | .90 | .85 | .94 | .89 | .68 |
| Average | .90⅜ | .85⅜ | .93⅝ | .88⅝ | .93⅜ | .88⅜ | .67⅜ |
| Average of North Lima, South Lima, and Indiana | .88⅜ | | .91⅛ | | .90⅝ | | |

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last six years:

*Highest, lowest, and average prices of Lima (Ohio) crude petroleum, 1902–1907, per barrel.*

| Year | Highest. | Lowest. | Average. | Year. | Highest. | Lowest. | Average. |
|---|---|---|---|---|---|---|---|
| 1902 | [a] $1.15 | [b] $0.80 | $0.88¼ | 1905 | [a] $1.01 | [b] $0.81 | $0.88⅜ |
| 1903 | [a] 1.38 | [b] 1.06 | 1.16¼ | 1906 | [a] .98 | [b] .85 | .91⅛ |
| 1904 | [a] 1.36 | [b] .95 | 1.10⅜ | 1907 | [a] .94 | [b] .85 | .90⅝ |

[a] North Lima. [b] South Lima.

## INDIANA.

### PRODUCTION.

In the following table are shown the output and value of the oil produced in the State of Indiana during the years 1906 and 1907:

*Production and value of petroleum in Indiana in 1906 and 1907, by kinds, in barrels.*

| Kind. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Trenton rock | 7,665,408 | $6,760,890 | 5,119,039 | $4,526,893 |
| Corniferous rock | 8,069 | 9,176 | 8,998 | 10,037 |
| Total | 7,673,477 | 6,770,066 | 5,128,037 | 4,536,930 |

In the following table will be found a statement of the production of petroleum in Indiana from 1902 to 1907:

*Production of petroleum in Indiana, 1902–1907, in barrels.*

| Year. | Quantity. | Total value at wells of all oil produced, excluding pipeage. | Price per barrel. |
|---|---|---|---|
| 1902 | 7,480,896 | $6,526,622 | $0.87 |
| 1903 | 9,186,411 | 10,474,127 | 1.14 |
| 1904 | 11,339,124 | 12,235,674 | 1.08 |
| 1905 | 10,964,247 | 9,404,909 | .858 |
| 1906 | 7,673,477 | 6,770,066 | .882 |
| 1907 | 5,128,037 | 4,536,930 | .8847 |

## ILLINOIS.

The rapidity with which the Illinois oil field developed was the most surprising feature of the world's petroleum industry in 1907.

The existence of petroleum in Illinois has been recognized for many years, and a slight production has been noted. Repeated efforts were made years ago to develop the field, but the system of drilling used served to introduce enough water into the oil sands to shut off the oil and to hide the quantity of oil available. It was not until 1905 that more careful drilling in the neighborhood of Casey, in Clark County, developed wells sufficiently productive to indicate a large and profitable field. In 1905 the product amounted to only 181,084 barrels. In 1906 this increased to 4,397,050 barrels, and again five-fold in 1907 to 24,281,973 barrels. The details of the historical development should be consulted in the circular bulletins published by Dr. H. Foster Bain, director of the Illinois State Geological Survey, from which the following description is taken:

> The year just closed was a very prosperous one in the petroleum fields of Illinois. The area was extended rapidly to the southeast, many gaps were filled in, new and lower sands were tapped, additional pipe lines were laid, a new refinery was built, and the output was phenomenal.
>
> There are now collecting mains extending from north to south throughout the field and four 8-inch lines (or an equivalent) from Martinsville, the central pumping plant, eastward across Indiana. A new line has recently been put in service, running westward to a large refinery built this year near Alton, Ill., by the Standard Oil Company.
>
> *Commercial conditions.*—This enormous development was accomplished in a thoroughly business-like and quiet manner. Leases are selling at very good prices and a bonus of $150 to $200 an acre with a royalty of one-eighth is not uncommonly demanded in the productive district. At the same time there was little speculation by those not familiar with the oil business and its risks. Practically none of the usual stock-peddling companies were organized, and there is a strong sentiment against them.
>
> Experienced men have found this field an unusually profitable one despite the high bonus asked and certain other drawbacks. One conservative operator estimates that three out of four will make money. It is by no means unusual for a well to flow enough oil to pay for itself by the time it is connected up, and initial productions of 1,000 barrels are not uncommon. So far the wells have stood up well under pumping. The most northerly, or Westfield pool, is the only one which is even approximately drilled in. It was here that oil was first found and the shallow depth, 350 to 400 feet, has made its exploitation rapid. In October a careful estimate showed that the wells of this pool were yielding an average of about 6 barrels daily and many

of them had been pumped more than two years. The Crawford County wells were at the same time estimated to be yielding 20 barrels, while those of Lawrence County were yielding 40 barrels.

*Occurrence.*—The oil occurs in a number of isolated pools, which, however, are being brought closer together by drilling. It is not improbable that they will eventually be found to overlap. To the north they are higher stratigraphically and also shallower in depth. The Westfield pool is in the Upper Coal Measures. Most of the oil in Crawford County seems to come from the Lower Coal Measures, well down toward the base. In Lawrence County there are three sands, the main production being from the Buchanan sand at 1,300 feet. This probably represents the Mansfield sandstone of the Indiana geologists, an approximate equivalent of the Pottsville strata of the East. The Kirkwood sand at 1,600 feet may also be Pottsville, though this is as yet uncertain. Farther south in the Princeton, Ind., field a still lower horizon in the Chester group is productive.

*The year's developments.*—In general the year's work resulted in extending the field to the south and in connecting up intervening territory. Wild-catting was active in other parts of the State, but so far without much result. Some gas has been found near Medora, and one or two oil wells have been brought in at Sparta, but as yet too little has been done to test thoroughly any considerable portion of the field.

In the report for 1906 the Illinois oil field was grouped with the Lima-Indiana field; the geological conditions are, however, entirely different, and the character of the oils resulting therefrom necessitates placing the Illinois field by itself. The petroleum is found in limestone as well as in sandstone lenses embedded in shales, and the oils vary correspondingly in the percentage of sulphur which they contain.

In 1907 drilling was carried on in the following counties: Clark, Cumberland, Crawford, Coles, Edgar, Lawrence, Jasper, Clinton, Randolph, Wabash, Wayne, White, Richland, St. Clair, McDonough, Montgomery, McLean, Hamilton, Jefferson, Shelby, Moultrie, Edwards, Williamson, Fayette, Clay, Douglas, Madison, Franklin, Washington, and White.

The following table gives a record of wells completed in the principal counties of Illinois in 1907:

*Well record in Illinois in 1907, by counties.*[a]

| County. | Completed. | Oil. | New production. | Dry holes. |
|---|---|---|---|---|
| Crawford | 2,840 | 2,464 | 83,263 | 376 |
| Clark | 1,176 | 975 | 20,385 | 201 |
| Lawrence | 690 | 620 | 30,543 | 70 |
| Cumberland | 152 | 139 | 3,612 | 13 |
| Coles | 56 | 45 | 314 | 11 |
| Edgar | 25 | 11 | 118 | 14 |

[a] Taken from Circular Illinois State Geol. Survey.

## PRODUCTION.

The total production, by months, for the last three years is given in the following table:

*Production of crude petroleum in Illinois, 1905–1907, by months, in barrels.*

| Month. | 1905. | 1906. | 1907. |
|---|---|---|---|
| January |  | 55,680 | 781,812 |
| February |  | 65,208 | 956,399 |
| March |  | 19,352 | 1,547,323 |
| April |  | 102,862 | 1,874,465 |
| May |  | 267,746 | 2,138,918 |
| June | 6,521 | 410,655 | 1,879,362 |
| July | 17,306 | 610,401 | 2,422,192 |
| August | 23,827 | 778,464 | 2,446,042 |
| September | 26,586 | 722,168 | 2,606,663 |
| October | 27,589 | 463,819 | 2,863,812 |
| November | 34,611 | 350,985 | 2,510,146 |
| December | 44,644 | 549,710 | 2,255,839 |
| Total | 181,084 | 4,397,050 | 24,281,973 |

*Production and value of crude petroleum in Illinois, 1905–1907, in barrels.*

| Year. | Ohio Oil Company. | Other lines. | Total quantity. | Total value. |
|---|---|---|---|---|
| 1905 | 156,503 | 24,581 | 181,084 | $116,561 |
| 1906 | 4,385,471 | 11,579 | 4,397,050 | 3,274,818 |
| 1907 | 23,733,790 | 548,183 | 24,281,973 | 16,432,947 |

The following table shows the runs of the Ohio Oil Company during the years 1905, 1906, and 1907, and shipments and stocks in 1907, by months:

*Pipe-line runs of the Ohio Oil Company in Illinois in 1905, 1906, and 1907, and shipments and stocks in 1907, by months, in barrels.*

| Month. | Pipe-line runs. |  | 1907. |  |  |
|---|---|---|---|---|---|
|  | 1905. | 1906. | Pipe-line runs. | Shipments. | Stocks. |
| January |  | 55,680 | 752,671 | 142,001 | 2,509,598 |
| February |  | 65,208 | 948,620 | 401,344 | 3,040,111 |
| March |  | 19,352 | 1,494,508 | 444,078 | 4,117,635 |
| April |  | 102,862 | 1,823,025 | 385,432 | 5,528,759 |
| May |  | 267,746 | 2,094,195 | 563,585 | 7,117,033 |
| June | 5,489 | 410,655 | 1,830,634 | 551,502 | 8,448,344 |
| July | 9,208 | 610,401 | 2,376,281 | 1,395,238 | 9,387,999 |
| August | 15,092 | 778,464 | 2,398,895 | 1,440,640 | 10,335,000 |
| September | 19,592 | 722,168 | 2,560,563 | 1,105,589 | 12,557,522 |
| October | 26,444 | 463,819 | 2,818,032 | 1,590,566 | 13,724,691 |
| November | 34,766 | 350,985 | 2,464,981 | 1,815,964 | 14,275,036 |
| December | 45,912 | 538,131 | 2,201,265 | 848,450 | 15,751,305 |
| Total | 156,503 | 4,385,471 | 23,733,790 | 10,684.389 | ............ |

The following table shows the quantity of crude petroleum shipped by railroad from the Illinois oil field during 1906 and 1907, by months:

*Shipments of crude petroleum by railroad in tank cars from Illinois oil field, in pounds and equivalent in barrels, in 1906, by months.*

| Month. | 1906.[a] |  | 1907.[b] |  |
|---|---|---|---|---|
|  | Pounds. | Barrels. | Pounds. | Barrels. |
| January | 18,083,407 | 60,134 | 2,607,940 | 8,701 |
| February | 15,444,464 | 51,358 | 4,361,996 | 14,598 |
| March | 4,814,239 | 16,009 | 7,158,170 | 23,947 |
| April | 10,687,154 | 35,539 | 12,609,699 | 42,249 |
| May | 48,151,478 | 160,121 | 47,076,459 | 158,227 |
| June | 941,669,378 | 3,131,383 | 49,701,853 | 166,644 |
| July | 155,158,474 | 515,956 | 96,137,954 | 322,622 |
| August | 160,831,482 | 534,821 | 66,661,072 | 223,134 |
| September | 110,852,921 | 368,625 | 21,203,105 | 70,555 |
| October | 48,881,173 | 162,547 | 17,055,726 | 56,570 |
| November | 14,659,266 | 48,747 | 16,831,726 | 56,060 |
| December | 9,275,053 | 30,843 | 19,952,993 | 66,692 |
| Total | 1,538,508,489 | 5,116,082 | 361,358,693 | 1,210,019 |

[a] Calculations are made on the basis of 7.16 pounds to the gallon. Shipments were made from Bridgeport, Oilfield, and Stoy. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore and Ohio, the Cincinnati, Hamilton and Dayton, and the Indianapolis Southern.

[b] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel. Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Oilfield, and Casey The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore and Ohio, the Cincinnati, Hamilton and Dayton, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago and St. Louis.

## PRICES.

The price of Illinois crude oil per barrel at wells in 1907 fluctuated from 64 cents on January 1 to 66 cents on February 11 and 68 cents on March 9, at which price it remained for the rest of the year.

*Average monthly prices of Illinois crude petroleum in 1905, 1906, and 1907, per barrel.*

| Month. | 1905. | 1906. | 1907. |
|---|---|---|---|
| January |  | $0.79 | $0.64 |
| February |  | .79 | .65¼ |
| March |  | .79 | .67½ |
| April |  | .80⅝ | .68 |
| May |  | .83 | .68 |
| June | $0.60 | .83 | .68 |
| July | .60 | .82¾ | .68 |
| August | .60 | .71⅞ | .68 |
| September | .61 | .64 | .68 |
| October | .64 | .64 | .68 |
| November | .66 | .64 | .68 |
| December | .70 | .64 | .68 |
| Average | .644 | .745 | .67⅜ |

## INVESTIGATION OF ILLINOIS PETROLEUMS.

In February, 1908, the United States Geological Survey sent Mr. John P. Dunlop into the Illinois field to collect representative samples of the oils, the localities being selected in conference with Dr. H. Foster Bain, the State geologist. These samples were shipped to Washington, where they were examined by the writer. The samples were examined as to odor, color, and specific gravity, and then distilled by the Engler distillation apparatus. The quantity distilling up to 150° C. was classed as naphtha, and that between 150° and 300° C. as illuminating oil. The determination of the sulphur content of the oils was made in the Pittsburg laboratory of the Survey's Technologic Branch.

The methods used in these oil tests have been selected because of their simplicity, which enables the tests to be carried rapidly to completion, and the treatment of all the samples in precisely the same manner affords a basis for a just comparison of the oils. Oils from 34 wells were examined.

The oils range in gravity from 39.5° B. in the deep wells (1,500 feet) in the Bridgeport pool to 22.3° B. in the Duncansville pool. Some of the shallow wells (300 feet) in the north end of the field also yield oils as light as 35.5° B.

No oil was found with more than one-half of 1 per cent of sulphur, and this only in the extreme north end of the field. Farther south the average is about one-fourth of 1 per cent, and the oils are acceptable as nonsulphur oils. Pipe-line samples from all pools averaged still less—that is, 0.2 per cent.

The percentage distilling below 150° C. ranged from 1 to 21, averaging 13.2 per cent for the State. The illuminating oil averaged 31.2 per cent.

Most of the oils contained considerable proportions of paraffin wax and practically no asphalt.

*Tests of Illinois petroleum.*

| No. of specimen. | Location of well. | No. of well. | Depth of well. | Physical properties. | | | | | Distillation by Engler's method. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gravity. | | Color. | Odor. | Sulphur. | Begins to distill at— | By volume. | | | | By weight (per cent). | | |
| | | | | | | | | | | To 150° C. | | 150° to 300° C. | | | | |
| | | | | Specific. | Baumé. | | | | | Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | To 150° C. | 150° to 300° C. | Total volatile. |
| | Oilfield pool, Parker Township, Clark County: | | *Feet.* | | | | | *P. ct.* | °C. | | | | | | | |
| 23 | S. Spellbring farm, sec. 7; Ohio Oil Co. | 7 | 330 | 0.846 | 35.5 | Light green | High sulphur | 0.48 | 63 | 14.0 | 0.7745 | 31.0 | 0.8145 | 12.6 | 29.8 | 42.4 |
| 24 | M. K. Young farm, sec. 18; Ohio Oil Co. | 27 | 330 | .846 | 35.5 | do | do | .35 | 55 | 10.5 | .7357 | 34.0 | .8184 | 9.1 | 32.8 | 41.9 |
| 25 | G. H. Jeffries farm, sec. 20; Ohio Oil Co. | 21 | 325 | .854 | 33.9 | do | do | .47 | 55 | 15.5 | .7323 | 30.5 | .8173 | 13.3 | 29.2 | 42.5 |
| | Parker Township pool, Clark County: | | | | | | | | | | | | | | | |
| 26 | J. Turner lease, sec. 33; Ohio Oil Co. | 3, 4, 5, 6, 7, 10, 11 | ± 300 | .879 | 29.2 | Medium green | Sulphur | .30 | 65 | 8.5 | .7557 | 25.0 | .8278 | 7.3 | 23.5 | 30.8 |
| 29 | Do | 12 | ± 300 | .879 | 29.2 | Brown | High sulphur | .37 | 65 | 8.0 | .7008 | 27.0 | .8268 | 6.3 | 25.3 | 31.6 |
| 27 | Kelly farm, sec. 33; Treat & Crawford | 1, 2, 3, 4 | 300 | .865 | 31.8 | Light green | Sulphur | .48 | 75 | 11.5 | .7433 | 30.5 | .8193 | 9.8 | 28.8 | 38.6 |
| 28 | M. J. Linn farm; Mars Oil and Gas Co. | 1-9 | 280-320 | .853 | 32.9 | do | do | .38 | 65 | 14.0 | .7473 | 25.0 | .8216 | 12.1 | 23.9 | 36.0 |
| | Siggins pool, Union Township, Cumberland County: | | | | | | | | | | | | | | | |
| [a]16 | Queen farm, sec. 13; Campbell, McElroy & Bell. | 5, 8, 9, 10, 11, 13, 21 | ± 400 | .839 | 36.8 | do | do | .20 | 60 | 18.0 | .7211 | 38.0 | .8146 | 15.4 | 36.9 | 52.3 |
| [a]17 | Do | 1, 2, 3, 4, 17, 18, 19 | ± 400 | .841 | 36.4 | do | do | .17 | 60 | 18.0 | .7261 | 30.0 | .8071 | 15.4 | 28.8 | 44.2 |
| [b]18 | Underwood lease, sec. 13; Ohio Oil Co. | 17 | 577 | .878 | 29.4 | do | do | .33 | 80 | 10.1 | .7190 | 34.0 | .8215 | 9.4 | 31.8 | 41.2 |
| | Johnson Township pool, Clark County: | | | | | | | | | | | | | | | |
| [c]19 | W. D. Misner lease; Pure Oil Co. | 6 | 606 | .863 | 32.2 | | | .23 | 75 | 11.5 | .7318 | 35.0 | .8174 | 9.7 | 33.1 | 42.8 |
| [c]20 | M. Misner lease; Pure Oil Co. | 7 | 610 | .866 | 31.6 | Dark green | Sulphur | .30 | 75 | 8.0 | .7193 | 32.0 | .8008 | 6.6 | 29.8 | 36.4 |
| [d]21 | Z. E. Brant farm, sec. 26; Ohio Oil Co. | 2 | 480 | .868 | 31.2 | Light green | do | .27 | 75 | 10.5 | .7261 | 30.5 | .8141 | 8.7 | 28.6 | 37.3 |
| [d]22 | Z. E. Brant farm, sec. 26; Ohio Oil Co. | 5 | 474 | .879 | 29.2 | Medium green | do | .24 | 75 | 10.0 | .7275 | 33.0 | .8186 | 8.4 | 31.1 | 39.5 |
| | Robinson pool, Crawford County: | | | | | | | | | | | | | | | |
| 1 | Mitchell Oil Co. | 1, 2, 3 | ± 950 | .846 | 35.5 | do | Aromatic | .16 | 80 | 8.0 | .7183 | 39.0 | .7941 | 6.7 | 36.6 | 43.3 |
| 2 | Graswald lease; G. E. Thomas | 1 | 970 | .854 | 33.9 | Light green | do | .17 | 60 | 16.0 | .7330 | 34.0 | [e].8135 | 13.7 | 32.3 | 46.0 |
| 4 | Miller lease; Fisher Oil Co. | 2 | 945 | .871 | 30.7 | do | do | .19 | 80 | 11.5 | .7531 | 32.0 | .8266 | 9.9 | 30.3 | 40.2 |
| 3 | Quick lease; John Markham | 7 | 960 | .839 | 36.8 | Dark green | do | .15 | 51 | 20.0 | .7205 | 32.0 | .8107 | 17.1 | 30.9 | 48.0 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Duncansville pool, Montgomery Township, Crawford County:** | | | | | | | | | | | | | | | |
| 5 | **J. W. Creswell** | 1 | 970 | .915 | 23.0 | Brown | Sulphur | .39 | 80 | 1.0 | ...... | 24.5 | .8391 | ...... | 22.4 | ...... |
| 6 | **Higgins lease; M. Bernstein Co.** | 1 | 965 | .919 | 22.3 | do | do | .39 | 75 | 4.0 | ...... | 20.0 | .8507 | ...... | 18.5 | ...... |
| | **Bridgeport pool, Petty Township, Lawrence County:** | | | | | | | | | | | | | | | |
| f9 | **W. E. Neil lease; Braden Oil Co.** | 3 | 1,435 | .833 | 38.0 | Light green | Like Pennsylvania oil. | .17 | ...... | 21.0 | .7106 | 33.0 | .8110 | 17.9 | 32.1 | 50.0 |
| d8 | Eshelman lease; Bridgeport Oil Co. | 2 | ± 900 | .854 | 33.9 | Dark green | do | .24 | 47 | 15.0 | .7175 | 32.0 | .8211 | 12.6 | 30.7 | 43.3 |
| c7 | Do | 4 | ± 900 | .865 | 31.8 | do | do | .25 | 70 | 14.5 | .7197 | 31.0 | .8218 | 12.0 | 29.4 | 41.4 |
| 10 | Thorn lease, south of Bridgeport; Ohio Oil Co. (Buchanan sand). | 2, 12 | ±1,300 | .855 | 33.7 | Medium green | do | .25 | 80 | 16.0 | .7193 | 31.0 | .7923 | 13.8 | ...... | ...... |
| 11 | Do | 13, 14, 17 | ±1,300 | .855 | 33.7 | do | do | .20 | 68 | 16.5 | .7268 | 41.0 | .8193 | 14.0 | 39.3 | 53.3 |
| 12 | Do | 8, 10 | ±1,300 | .856 | 33.5 | Light green | ...... | .21 | 75 | 14.0 | .7248 | 32.0 | .8188 | 11.8 | 30.6 | 42.4 |
| 14 | Macpherson lease (100 acres), Kirkwood Oil Co. (Kirkwood sand). | 1 | ±1,500 | .828 | 39.0 | Dark green | ...... | .13 | 45 | 21.0 | .7313 | 25.0 | .8103 | 18.5 | 24.4 | 42.9 |
| 15 | Macpherson lease (20 acres); Kirkwood Oil Co. (Kirkwood sand). | 1 | ±1,500 | .826 | 39.5 | Medium green | ...... | .17 | 40 | 23.0 | .7113 | 31.5 | .8101 | 19.8 | 30.9 | 50.7 |
| | Pipe line, Ohio Oil Co., Martinsville: | | | | | | | | | | | | | | | |
| 33 | Northern part Clark County | ...... | ...... | .876 | 29.8 | do | Slight sulphur | .26 | 80 | 11.0 | .7371 | 29.5 | .8147 | 9.2 | 27.4 | 36.6 |
| 32 | Siggins pool, Union Township, Cumberland County. | ...... | ...... | .869 | 31.1 | do | do | .19 | 80 | 13.0 | .7268 | 33.0 | .7983 | 10.8 | 30.3 | 41.1 |
| 34 | Johnson Township, south part of Clark County. | ...... | ...... | .878 | 29.4 | Light green | do | .23 | 70 | 10.0 | .7326 | 33.0 | .8183 | 8.3 | 30.7 | 39.0 |
| 30 | Crawford County | ...... | ...... | .855 | 33.7 | do | Aromatic | .17 | 75 | 15.0 | .7338 | 37.0 | .8103 | 12.8 | 35.0 | 47.8 |
| 31 | Lawrence County | ...... | ...... | .847 | 35.2 | do | Like Pennsylvania oil. | .17 | 71 | 15.0 | .7276 | 34.0 | .8053 | 12.8 | 32.3 | 45.1 |

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[a] Oil from first sand.

[b] Lower sand oil; contains 8 per cent of water.

[c] Lower sand oil.

[d] Upper sand oil.

[e] Last 10 cubic centimeters of burning oil had specific gravity 0.837.

[f] Lower sand oil; contains 5.04 per cent of asphalt.

## MID-CONTINENT FIELD.

The area included in this field consists of southeastern Kansas, the oil regions in the new State of Oklahoma, and northern Texas. The field is naturally bounded on the south by the uplift, which has rendered the rocks too disturbed to admit of their containing valuable oil supplies.

The geological conditions prevailing in the Mid-Continent field have been discussed in previous reports. Kansas has developed twenty-five oil and gas pools, ranging generally from northeast to southwest through the following counties: Franklin, Miami, Coffey, Anderson, Linn, Greenwood, Bourbon, Allen, Woodson, Wilson, Neosho, Sumner, Cowley, Chautauqua, Montgomery, and Labette. They continue to the southwest in Oklahoma. Farther south the wells are deeper, and with depth the oils become lighter in gravity and contain less asphalt. During 1907 drilling was very dormant in the Kansas field, but the enormous development of the Glenn pool stimulated development in all parts of Oklahoma. The most significant extensions of area were north and south of the Glenn pool, the development of the Delaware pool, and the increased activity in the Morris pool. The finding of valuable wells in the old Muskogee field indicates that much oil will be developed between Muskogee and Okmulgee. The tendency to look for oil at greater depth has been rewarded to some extent near the Glenn pool, but it is evident that the limitations both in area and depth of the Oklahoma pools have not yet been reached, and no safe predictions can be made as to the probable developments of the next few years.

The following are the principal oil districts in the State of Oklahoma:

- Cherokee Nation:
  - Shallow sand
    - Childers.
    - Coodys Bluff.
    - Delaware.
    - Alluwe.
    - Chelsea.
  - Deep sand
    - Copan.
    - Webber.
    - Bartlesville.
    - Caney River.
    - Hogshooter.
    - Ramona.
    - Bird Creek.
- Osage Reservation:
  - Cleveland.
- Creek Nation:
  - Glenn pool.
  - Redfork.
  - Morris.
  - Bald Hill.
  - Muskogee
    - City field (old field).
    - New field.
- Chickasaw Nation:
  - Wheeler.
- Seminole Nation:
  - Wewoka.
- Kiowa County.
  - Gotebo.

After repeated hearings of all interests concerned, the Secretary of the Interior revised the regulations governing leasing of oil and gas lands of members of the Five Civilized Tribes. Copies can be obtained from the Secretary's office by asking for "Revised Regulations of April 20, 1908."

## PRODUCTION.

As in the year 1906, interest in the Kansas field was entirely subordinated to Oklahoma, with the result of only one-tenth as many wells being drilled in Kansas as in the new State. The total production for the field amounted to 46,846,267 barrels, more than double the output of 22,836,553 barrels in 1906. A dominant feature of this great production was the output of the Glenn pool.

*Glenn pool.*—The history of the discovery and rapid development of the Glenn pool was given in this report for 1906. At the beginning of 1907 this pool was showing a monthly production of 385,939 barrels of oil. This increased rapidly until October, in which month the enormous aggregate of 2,441,622 barrels was produced. From this culminating figure the pool began to decline, in spite of active drilling and encouraging the wells with nitroglycerine, and in two months at the close of the year it had declined to the rate of six months before.

At the beginning of the year the estimate for the production of 1907 was about 30,000,000 barrels for the entire Mid-Continent field, but the actual product so far outstripped this as to render it a grave problem to take care of the enormous supply. This was accomplished chiefly by the large number of steel storage tanks built by the Prairie Oil and Gas Company and by private producers, with a smaller number by the Texas company and the Gulf company. About 100 steel tanks built by the producers were bought by the Prairie Oil and Gas Company full of oil, the tanks being bought at cost to the producers. At the beginning of the year the project of building two pipe lines, one by the Texas company and the other by the Gulf company, from the Glenn pool to the Gulf, was undertaken and capitalized, and it was finished by the time the Glenn pool reached its maximum output. These 8-inch pipe lines, one 430 and the other 450 miles in length, built with record-breaking rapidity, served to relieve the congestion of oil.

The details of the Gulf Pipe Line follow.

The line as at present constructed has six pumping stations, as follows: Watkins and Chambers in Oklahoma, and Lenoir, Big Sandy, Lufkin, and Sour Lake in Texas. The distance between stations is as follows: Watkins to Chambers, 79 miles; Chambers to Lenoir, 78 miles; Lenoir to Big Sandy, 89 miles; Big Sandy to Lufkin, 82 miles; Lufkin to Sour Lake, 91 miles.

The station at Watkins is of a somewhat temporary character, the pumps in use being simple duplex noncondensing steam pumps of size 18 inches by 5 inches by 18 inches, operated by steam from boilers, the fuel for which is natural gas from the Glenn pool field.

The station at Chambers is of modern design and construction, having three main pumps which are triple expansion duplex condensing, size 11 inches by 17 inches by 28 inches by 5¼ inches by 24 inches. They are operated by steam from boilers, the fuel for which is bituminous coal.

The stations at Lenoir, Big Sandy, and Lufkin, Tex., are alike in construction. In each station are four units of Gould's triplex power pumps, whose plungers are 5¼ inches by 16 inches. Each of these pumps is operated by a Hornsby-Akroyd oil engine of single cylinder type, each of nominal capacity of 90 horsepower, and each operated by crude oil as fuel.

Two 37,500-barrel working tanks are located at each of the four last-mentioned pumping stations.

At Sour Lake connection is made with the Gulf Pipe Line Company's 6-inch lines from Sour Lake to the Gulf Refining Company's refineries and docks at Port Arthur, Tex., 34½ miles distant.

The station at Sour Lake not only serves the purpose of pumping oil for the through pipe line system, but also for local lines of the company in the State of Texas. The pumps in use at Sour Lake are duplex compound condensing, operated by steam from boilers for which crude oil is used for fuel.

The capacity of the main line, with pumping stations as at present located and equipped, is 14,000 barrels daily. The main 8-inch line from Watkins to Sour Lake is almost an air line, with but few deflections. The work of pipe laying was started February 13, 1907, and was complete August 13, 1907, exactly six months later. The first oil was pumped from Watkins station, in the Glenn pool, August 15, 1907. The country traversed presented a number of difficult and peculiar engineering problems. A spur of the Ozarks, 1,200 feet high, had to be crossed, and for miles through this section there was no soil, the ditch being blasted into solid rock. The rainiest winter for years caused serious inconvenience, and numerous shallow prairie streams delayed the construction until enough pipe lengths could be screwed together on the near shore, a windlass rigged up on the far shore, and the jointed sections pulled across the stream. Streams like the Neches River and Sulphur Creek were spread over bottoms miles wide. The directness of the course adopted required the hauling of practically all of the pipe from railroad unloading stations for distances in some cases as much as 20 miles, and in many instances the heavy sections of pipe, weighing 600 pounds each, had to be carried long distances on the shoulders of the laborers, owing to the roughness of the country traversed. The location of pumping stations at approximately equal distances apart, adjacent to water supply and at the proper elevation, involved unusual engineering skill.

More than 1,500 laborers, divided into 10 gangs, were employed in the work. A schedule of more than 2 miles per day was figured out in advance, and so accurate was the estimated rate of progress that when the gaps were closed up it was found that the various gangs of workmen had finished their work with an average difference of time as compared with the schedule of not more than four days.

The rate of flow of the oil in the line is such that but for the necessity of relaying at the intermediate stations only ten days would be required to transport it from one end of the pipe line to the other; one additional day for relaying at each station brings the total up to fifteen days.

The 8-inch pipe line of the Texas company begins at Tulsa and passes through Henryetta, Stuart, and Armstrong, Okla.; it crosses the Red River at Denison, and continues thence to Sherman, Dallas, Corsicana, Concord, Bobbin, and Humble, in Texas. At Humble it connects with the 6-inch system from that point to Port Arthur and Port Neches. This line takes in Dayton, Sour Lake, Beaumont, and Nederland. The line was commenced early in February, 1907, and completed in January, 1908. Its daily capacity is from 17,000 to 18,000 barrels.

At all of the trunk line stations there are at least two 37,500-barrel tanks. At Tulsa there are 32 of these tanks, at Dallas 14, at Corsicana 3, at Humble 5, at Sour Lake 7, at Beaumont (Garrison) 14, and at Nederland 12. In addition to this there are a large number of tanks connected with the refineries at Dallas, Port Arthur, and Port Neches.

In the following tables are shown the production and value of petroleum in the Mid-Continent field since 1889:

*Production of crude petroleum in the Mid-Continent oil field, 1889–1907, by States, in barrels.*

| Year. | Kansas. | Oklahoma. | Northern Texas.[a] | Total. |
|---|---|---|---|---|
| 1889 to 1895 | 110,530 | 287 | ........... | 110,817 |
| 1896 | 113,571 | 170 | 1,400 | 115,141 |
| 1897 | 81,098 | 625 | 65,925 | 147,648 |
| 1898 | 71,980 | ........... | 544,620 | 616,600 |
| 1899 | 69,700 | ........... | 668,483 | 738,183 |
| 1900 | 74,714 | 6,472 | [b]836,039 | 917,225 |
| 1901 | 179,151 | 10,000 | [b]800,545 | 989,696 |
| 1902 | 331,749 | 37,100 | 617,871 | 986,720 |
| 1903 | 932,214 | 138,911 | 501,960 | 1,573,085 |
| 1904 | 4,250,779 | 1,366,748 | 569,102 | 6,186,629 |
| 1905 | [c]12,013,495 | (d) | 520,282 | 12,533,777 |
| 1906 | [c]21,718,648 | (d) | 1,117,905 | 22,836,553 |
| 1907 | 43,524,128 | 2,409,521 | 912,618 | 46,846,267 |

[a] Includes counties of Navarro, Jack, and McLennan.
[b] Includes a small production in southern Texas.
[c] Includes the production of Oklahoma.
[d] Included in Kansas production.

In the following table is shown the total production of crude petroleum from the Mid-Continent field from 1889 to 1907, inclusive, with its percentage of the total production of the United States, and the quantity and percentage of increase and decrease each year:

*Production of crude petroleum in the Mid-Continent field, 1889–1907, in barrels.*

| Year. | Production. | Percentage of total production. | Increase. | Decrease. | Percentage. | |
|---|---|---|---|---|---|---|
| | | | | | Increase. | Decrease. |
| 1889 | 500 | ........... | ........... | ........... | ........... | ........... |
| 1890 | 1,200 | ........... | 700 | ........... | 140.00 | ........... |
| 1891 | 1,430 | ........... | 230 | ........... | 19.17 | ........... |
| 1892 | 5,080 | ........... | 3,650 | ........... | 255.24 | ........... |
| 1893 | 18,010 | 0.04 | 12,930 | ........... | 254.53 | ........... |
| 1894 | 40,130 | 0.08 | 22,120 | ........... | 122.82 | ........... |
| 1895 | 44,467 | 0.08 | 4,337 | ........... | 10.81 | ........... |
| 1896 | 115,141 | 0.19 | 70,674 | ........... | 158.93 | ........... |
| 1897 | 147,648 | 0.24 | 32,507 | ........... | 28.23 | ........... |
| 1898 | 616,600 | 1.11 | 468,952 | ........... | 317.62 | ........... |
| 1899 | 738,183 | 1.29 | 121,583 | ........... | 19.72 | ........... |
| 1900 | 917,225 | 1.44 | 179,042 | ........... | 24.25 | ........... |
| 1901 | 989,696 | 1.43 | 72,471 | ........... | 7.90 | ........... |
| 1902 | 986,720 | 1.12 | ........... | 2,976 | ........... | 0.30 |
| 1903 | 1,573,085 | 1.57 | 586,365 | ........... | 59.42 | ........... |
| 1904 | 6,186,629 | 5.28 | 4,613,544 | ........... | 293.28 | ........... |
| 1905 | 12,533,777 | 9.30 | 6,347,148 | ........... | 102.60 | ........... |
| 1906 | 22,836,553 | 18.05 | 10,302,776 | ........... | 82.20 | ........... |
| 1907 | 46,846,267 | 28.20 | 24,009,714 | ........... | 105.14 | ........... |

*Production and value of crude petroleum in the Mid-Continent field, 1905–1907, by States, in barrels.*

| Year. | Kansas and Oklahoma. | | Northern Texas. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 12,013,495 | $6,546,398 | 520,282 | $361,604 | 12,533,777 | $6,908,002 |
| 1906 | 21,718,648 | 9,615,198 | 1,117,905 | 740,542 | 22,836,553 | 10,355,740 |
| 1907 | 45,933,649 | 18,478,658 | 912,618 | 721,577 | 46,846,267 | 19,200,235 |

## STOCKS.

The statement of the production from this field refers entirely to the oil taken from the wells and sold or measured. In addition, there was an unusually great quantity of oil held by the producers on the leases. This is included under the head of field stocks, the actual quantity of which can not be accurately given, but which is estimated by the Oil Investors Journal to amount to about 6,650,000 barrels on January 1, 1908.

In addition to these stocks held by the producers the contents of the great steel tankage built during the year and of the tank farms already owned by the Prairie Oil and Gas Company make the total stocks at the close of 1907 in the Mid-Continent field amount to over 45,000,000 barrels.

## WELL RECORD.

The following table gives the well record in the Mid-Continent field for 1907:

*Well record in Mid-Continent field in 1907.*

| District. | Wells drilled. | | | | Abandoned. |
|---|---|---|---|---|---|
| | Oil. | Gas. | Dry. | Total. | |
| Northern Texas: | | | | | |
| Corsicana, Powell | 71 | 6 | 52 | 129 | 24 |
| Henrietta | 17 | 1 | 9 | 27 | 3 |
| South Bosque | 10 | ........ | 3 | 13 | ........ |
| Jack County | ........ | ........ | ........ | ........ | ........ |
| Total | 98 | 7 | 64 | 169 | 27 |
| Kansas [a] | [b] 74 | 268 | 81 | 423 | ([c]) |
| Oklahoma [a] | [b] 3,484 | 149 | 327 | 3,960 | ([c]) |
| Total | 3,558 | 417 | 408 | 4,383 | ([c]) |
| Grand total | 3,656 | 424 | 472 | 4,552 | ([c]) |

[a] Figures taken from Oil City Derrick.

[b] Kansas total initial production, 912 barrels; Oklahoma, 459,685 barrels.

[c] Unknown.

## KANSAS AND OKLAHOMA PRODUCTION.

*Production of crude petroleum in Kansas and Oklahoma in 1906 and 1907, by months, in barrels.*

| Month. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Pipe-line runs. | Shipments of crude by rail and consumption by refineries. | Total. | Pipe-line runs. | Shipments of crude by rail and consumption by refineries and fuel users. | Total. |
| January | 1,472,214 | 36,311 | 1,508,525 | 2,358,104 | 83,865 | 2,441,969 |
| February | 1,352,531 | 27,226 | 1,379,757 | 2,364,531 | 91,531 | 2,456,062 |
| March | 1,693,182 | 36,443 | 1,729,625 | 3,080,436 | 100,299 | 3,180,735 |
| April | 1,779,251 | 34,719 | 1,813,970 | 3,614,650 | 103,852 | 3,718,502 |
| May | 1,741,941 | 41,711 | 1,783,652 | 3,747,039 | 105,043 | 3,852,082 |
| June | 1,688,433 | 47,900 | 1,736,333 | 3,822,064 | 106,690 | 3,928,754 |
| July | 2,022,215 | 49,546 | 2,071,761 | 3,890,672 | 110,618 | 4,001,290 |
| August | 1,779,263 | 47,724 | 1,826,987 | 4,131,984 | 118,206 | 4,250,190 |
| September | 1,546,719 | 48,046 | 1,594,765 | 4,198,671 | 110,661 | 4,309,332 |
| October | 2,009,650 | 57,068 | 2,066,718 | 4,841,057 | 117,272 | 4,958,329 |
| November | 1,945,195 | 47,729 | 1,992,924 | 4,451,984 | 107,410 | 4,559,394 |
| December | 2,163,562 | 50,069 | 2,213,631 | 4,149,149 | 127,861 | 4,277,010 |
| Total | 21,194,156 | 524,492 | 21,718,648 | 44,650,341 | [a] 1,283,308 | 45,933,649 |

[a] Average quantity run to refineries.

## PRICES.

In the following tables are given the prices paid by the Prairie Oil and Gas Company for the oils of different grades in Kansas and Oklahoma during the years 1905, 1906, and 1907; also the average monthly price during 1906 and 1907:

*Range of prices paid for petroleum by the Prairie Oil and Gas Company in Kansas and Oklahoma in 1905, 1906, and 1907, per barrel.*

| Date. | 32° and above. | 31½° to 32°. | 31° to 31½°. | 30½° to 31°. | 30° to 30½°. | 29½° to 30°. | 29° to 29½°. | 28½° to 29°. | 28° to 28½°. | 22° to 28°.[a] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1905. | | | | | | | | | | |
| January 1 | $0.80 | $0.75 | $0.70 | $0.65 | $0.60 | $0.55 | $0.50 | $0.45 | $0.40 | $0.39 |
| January 5 | .77 | .72 | .67 | .62 | .57 | .52 | .47 | .42 | .37 | .36 |
| January 11 | .72 | .67 | .62 | .57 | .52 | .47 | .42 | .37 | .32 | .31 |
| January 31 | .70 | .65 | .60 | .55 | .50 | .45 | .40 | .35 | .30 | .29 |
| March 25 | .68 | .63 | .58 | .53 | .48 | | | | | |
| April 12 | .66 | .61 | .56 | .51 | .46 | | | | | |
| April 18 | .61 | .56 | .51 | .46 | .41 | | | | | |
| April 25 | .57 | .52 | .47 | .42 | .37 | | | | | |
| May 27 | .53 | .48 | .43 | .38 | .33 | | | | | |
| June 17 | .50 | .45 | .40 | .35 | .30 | .25 | | | | |
| September 12 | .50 | .46 | .42 | .38 | .34 | .30 | | | | |
| September 28 | .51 | .48 | .45 | .42 | .39 | .35 | | | | |
| October 20 | .52 | .49 | .46 | .43 | .40 | .35 | | | | |

| Date. | 32° and above. | Heavy. | Date. | 32° and above. | 31½° to 32°. | 31° to 31½°. | 30½° to 31°. | 30° to 30½°. | Heavy. |
|---|---|---|---|---|---|---|---|---|---|
| 1906.<br>January 1 | $0.52 | $0.35 | 1907.<br>January 1 | $0.39 | $0.36 | $0.33 | $0.30 | $0.27 | $0.26 |
| July 28 | .50 | .35 | February 11 | .40 | .37 | .34 | .31 | .28 | .27 |
| August 2 | .48 | .35 | March 9 | .41 | .38 | .35 | .32 | .29 | .28 |
| August 9 | .45 | .32 | | | | | | | |
| August 15 | .42 | .29 | | | | | | | |
| August 28 | .39 | .26 | | | | | | | |

[a] Heavy.

*Average monthly price of Kansas and Oklahoma crude petroleum, per barrel of 42 gallons, in 1906 and 1907, by months.*

| Month. | 1906. | | 1907. | |
|---|---|---|---|---|
| | 32° and above. | Heavy. | 32° and above. | Heavy. |
| January | $0.52 | $0.35 | $0.39 | $0.26 |
| February | .52 | .35 | .39⅗ | .26⅗ |
| March | .52 | .35 | .40¾ | .27¾ |
| April | .52 | .35 | .41 | .28 |
| May | .52 | .35 | .41 | .28 |
| June | .52 | .35 | .41 | .28 |
| July | .51¾ | .35 | .41 | .28 |
| August | .43⅞ | .30¾ | .41 | .28 |
| September | .39 | .26 | .41 | .28 |
| October | .39 | .26 | .41 | .28 |
| November | .39 | .26 | .41 | .28 |
| December | .39 | .26 | .41 | .28 |
| Average | .47 | .31⅛ | .40¾ | .27¾ |

## KANSAS.

*Production.*—The following table gives the production and sales of crude petroleum in Kansas in 1907:

*Production of crude petroleum in Kansas in 1907, in barrels.*

| | |
|---|---|
| Quantity piped from wells in Kansas to refineries | 449, 211 |
| Rail shipments in Kansas | 263, 881 |
| Estimated quantity piped from other wells in Kansas and sold | 1, 696, 429 |
| Total sales in Kansas | 2, 409, 521 |
| Total value | $965, 134 |

The United States Geological Survey sent out a special inquiry to each producer of petroleum in the United States to ascertain the quantity of oil produced and sold, together with a report of field operations, in order that, when this system is perfected, it will supplement the statistics obtained through pipe lines and other transportation companies, and afford a basis for ascertaining the production of oil in each county and each pool. Returns from Kansas are practically complete and show the following division by counties of the production already given. A portion of this given as "production" was taken from storage, but as it entered into consumption in 1907, it is considered as marketed production for that year.

*Quantity and value of petroleum produced and sold in Kansas in 1907, by counties.*

| County. | Quantity. | Value. |
|---|---|---|
| | *Barrels.* | |
| **Allen** | 190, 352 | $76, 246 |
| **Bourbon** | 7, 228 | 2, 895 |
| **Chautauqua** | 1, 142, 113 | 457, 474 |
| **Elk** | 26, 505 | 10, 616 |
| **Franklin** | 183, 124 | 73, 350 |
| **Labette** | 14, 457 | 5, 791 |
| **Miami** | 31, 324 | 12, 547 |
| **Montgomery** | 472, 266 | 189, 166 |
| **Neosho** | 337, 333 | 135, 119 |
| **Wilson** | 4, 819 | 1, 930 |
| Total | 2, 409, 521 | 965, 134 |

*Comparative analyses of Kansas petroleums.*—During the spring of 1908 Mr. J. P. Dunlop collected 104 samples of petroleum embracing all the developed pools of the Mid-Continent field. A sample of 1 gallon was collected from each well and a 5-gallon sample from each important tank farm or pipe line. These cans were sealed by soldering as soon as the cans were filled at the wells, and were then expressed direct to Washington. The examination of the well samples from the Kansas portion of the field has been completed as to specific gravity and comparative distillation tests, and these are given below as follows:

*Analyses of Kansas petroleums.*

| No. of specimen. | Location of well. | No. of well. | Depth of well. | Physical properties. | | | | Distillation by Engler's method. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gravity. | | Color. | Sulphur. | Begins to distill at— | By volume. | | | | By weight per cent. | | |
| | | | | Specific. | Degrees Baumé. | | | | To 150° C. | | 150°-300° C. | | To 150° C. | 150°-300° C. | Total volatile. |
| | | | | | | | | | Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | |
| | Coffeyville field, Montgomery County: | | Feet. | | | | | ° C. | | | | | | | |
| 106 | Gilroy lease, Montgomery Township: Brown Brokerage Co., Coffeyville. | 1 to 15 | 600 | 0.8861 | 28.0 | Dark green | 0.07 | 95 | 4 | ...... | 30 | 0.8155 | ...... | 27.6 | ...... |
| 107 | M. Davis lease, 4½ miles northeast Coffeyville; Dunkley & Odell, Coffeyville. | 1 to 40 | [a] 625 | .8717 | 30.6 | Dark green | .10 | 100 | 6 | 0.7289 | 33 | .803 | 5.0 | 30.4 | 35.4 |
| | Peru pool, Chautauqua County: | | | | | | | | | | | | | | |
| 108 | Pipe line sample, Peru and Sedan pools Peru station, Prairie Oil and Gas Co. Independence. | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 110 | Hills lease; Central Pool Oil Co., Peru (1½ miles south of Peru). | 1 to 12 | [a] 1,100 | .8521 | 34.3 | Dark green | .09 | 80 | 12 | .7160 | 30 | .7945 | 10.1 | 28.0 | 38.1 |
| 109 | F. G. Hills farm; Interstate Oil and Gas Co., Peru. | 1-2 | 1,070 | .8557 | 33.6 | Dark green | .14 | 110 | 7 | ...... | 37 | .7975 | ...... | 34.5 | ...... |
| 111 | Interstate lease; Pittsburg Crude Oil and Gas Co., Peru (south of Peru). | 1 | 1,100 | .8557 | 33.6 | Dark green | .11 | 105 | 10 | ...... | 30.5 | .7940 | ...... | 28.3 | ...... |
| 112 | Same lease | 6 | 1,100 | .8500 | 34.7 | Dark green | .11 | 66 | 13 | .7177 | 31.5 | .8015 | 10.1 | 29.7 | 39.8 |
| | Wayside pool, Montgomery County: | | | | | | | | | | | | | | |
| 113 | J. Hall's lease; Lynch & McSweeney, Wayside | 1-2 | 800 | .8696 | 31.0 | Black | .17 | 75 | 9.5 | .710 | 28 | .808 | 7.8 | 26.0 | 33.8 |
| 114 | Tank sample, same lease | 4 wells | ...... | .8777 | 29.5 | Black | ...... | 105 | 8 | .7338 | 30.5 | .8105 | 6.7 | 28.1 | 34.8 |
| | Bolton pool, Montgomery County: | | | | | | | | | | | | | | |
| 115 | G. L. Banks farm; Miller, Rider & Co., Independence. | 4 | 1,180 | .8424 | 36.2 | Dark green | ...... | 72 | 14 | .7273 | 29.5 | .8095 | 12.1 | 28.3 | 40.4 |
| 116 | Pipe line sample from Station 5; Prairie Oil and Gas Co., Independence. | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | Longton pool, Elk County: | | | | | | | | | | | | | | |
| 117 | Allen County Investment Co., Longton (3 miles from town). | 2 | 585 | .8637 | 32.1 | Black | .16 | 98 | 12 | .7205 | 27.5 | .7920 | 10.0 | 25.2 | 35.2 |
| 118 | Tank sample; Allen County Investment Co | 8 wells | ...... | .8631 | 32.2 | Black | .13 | 96 | 6 | ...... | 31 | .789 | ...... | 28.3 | ...... |
| | Neodesha pool, Wilson County: | | | | | | | | | | | | | | |
| 119 | D. Johnson farm, 2 miles from Neodesha; Dolly Johnson Oil and Gas Co., Neodesha. | 13 | 800 | .8373 | 37.2 | Dark green | .09 | 80 | 17 | .7172 | 30 | .8005 | 14.6 | 28.7 | 43.3 |
| 120 | Theo. Johnson lease, Prairie Oil and Gas Co. Independence. | 3 | 820 | .8368 | 37.3 | Black | .16 | 88 | 16 | .7158 | 36 | .7925 | 13.7 | 34.1 | 47.8 |
| 121 | Tank sample, D. Johnson farm; Dolly Johnson Oil and Gas Co., Neodesha. | 5 wells | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Humboldt pool, Allen County: | | | | | | | | | | | | | | |
| 122 | Tank sample; McKinley Crude Oil Co., Humboldt | | 850 | | | | | | | | | | | | |
| 123 | 1¼ miles south of Humboldt; McKinley Crude Oil Co., Humboldt. | 11 | 851 | .8861 | 28.0 | Black | .33 | 111 | 3.0 | | 25.0 | .8138 | | 23.0 | |
| 124 | Frank Fursman (Humboldt) Logan Township | 1 | 850 | .8822 | 28.7 | Black | .31 | 108 | 5.0 | | 26.5 | .8205 | | | |
| 125 | Same lease | 3 | 850 | .8861 | 28.0 | Very dark green | .27 | 80 | 4.5 | | 26.0 | .8203 | | 24.1 | |
| | Chanute pool, Neosho County: | | | | | | | | | | | | | | |
| 126 | Hedrick lease; I. N. Knapp, Chanute (1½ miles east of Chanute). | 6 | 700 | .8706 | 30.8 | Dark green | .21 | 125 | 3 | | 37.5 | .8029 | | 34.6 | |
| 127 | Beach lease, 2½ miles southeast of Chanute; Rex Oil and Gas Co., Chanute. | 16 | 751 | .8647 | 31.9 | Dark green | .17 | 109 | 5 | | 36.0 | .7993 | | 33.3 | |
| 128 | Same lease | 12 | 737 | .8647 | 31.9 | Dark green | .18 | 110 | 6 | | 36.0 | .7992 | | 33.3 | |
| 129 | Tank sample; Chanute field; Kansas Cooperative Refining Co., Chanute. | | | | | | | | | | | | | | |
| 130 | Pipe line sample; Chanute Refining Co., Chanute | | | | | | | | | | | | | | |
| | Erie pool, Neosho County: | | | | | | | | | | | | | | |
| 131 | Tank of Northland Oil and Gas Co., Erie, on Webb's farm (1 month old). | | | | | | | | | | | | | | |
| 132 | Berger lease; Buckeye Oil and Gas Co., Erie | 2 | 520 | | | | | | | | | | | | |
| | Moran pool, Allen County: | | | | | | | | | | | | | | |
| 133 | Carroll lease; Eastern Kansas Oil Co., Moran | 4 | 735 | .8794 | 29.2 | | .21 | 95 | 8 | | 29.0 | .8137 | | 27.1 | |
| 134 | Smith lease; Eastern Kansas Oil Co., Moran | 2 | 735 | .8799 | 29.1 | Black | .22 | 78 | 10.0 | .7105 | 25.5 | .8125 | 8.1 | 23.5 | 31.6 |
| 135 | Pipe line samples; Eastern Kansas Oil Co., refinery near Moran. | | | .8557 | 33.6 | Black | .16 | 76 | 11.5 | .7116 | 29.5 | .795 | 9.6 | 27.4 | 37.0 |
| 136 | E. F. Holman, Moran | 3 | 735 | .8712 | 30.7 | Black | .17 | 75 | 7.5 | | 25.0 | .8135 | | 23.3 | |
| | Paola pool, Miami County: | | | | | | | | | | | | | | |
| 137 | C. J. Hafey, Paola | 4 | 360 | .8547 | 33.8 | Black | .18 | 86 | 15.0 | .7046 | 34.0 | .7912 | 12.4 | 31.5 | 43.9 |
| | Rantoul pool, Franklin County: | | | | | | | | | | | | | | |
| 138 | Springer lease; Hardison & Streeter, Rantoul | 1 to 4 | 350 | | | | .17 | | | | | | | | |
| 139 | Tullows lease; Hardison & Streeter, Rantoul | 6 | 350 | .8750 | 30.0 | Black | | 136 | 1.0 | | 39.5 | .7892 | | 35.6 | |
| 140 | Tank sample, Rantoul station; Prairie Oil and Gas Co., Rantoul. | | | | | | | | | | | | | | |

a Average.

## OKLAHOMA.

*Production.*—The following table shows the production and sales of crude petroleum in Oklahoma in 1907:

*Production of crude petroleum in Oklahoma in 1907, in barrels.*

| | |
|---|---|
| Estimated quantity shipped from Glenn pool and sold | 19,926,995 |
| Quantity piped from wells in Oklahoma to refineries | 373,372 |
| Estimated quantity piped from other wells in Oklahoma and sold | 23,048,806 |
| Rail shipments (outside Glenn pool) in Oklahoma | 174,955 |
| Total sales in Oklahoma | 43,524,128 |
| Total value | $17,513,524 |

During the year 1907 more rapid development of the oil and gas resources of the former Indian Territory was made than at any time preceding. This was especially true in the lands of the Creek Nation, the greatest activity in this direction having been heretofore in the Cherokee Nation. There has been some prospecting in the Chickasaw, Choctaw, and Seminole nations, and many thousands of acres of Indian land have been leased.

The large increase in the production of oil in the fields of the former Indian Territory is shown by the following statement, which has been prepared from the most reliable sources and gives the approximate number of barrels of oil marketed during each month of the fiscal year ending June 30, 1907:

*Oil marketed from Indian lands during fiscal year ending June 30, 1907.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| July, 1906 | 980,000 | February, 1907 | 1,707,000 |
| August, 1906 | 990,000 | March, 1907 | 2,366,000 |
| September, 1906 | 925,000 | April, 1907 | 2,970,000 |
| October, 1906 | 1,265,000 | May, 1907 | 3,154,000 |
| November, 1906 | 1,250,000 | June, 1907 | 3,150,000 |
| December, 1906 | 1,365,000 | | |
| January, 1907 | 1,595,000 | Total | 21,717,000 |

A vast quantity of the oil produced in the Creek and Cherokee nations is stored in tanks, it being estimated that on June 30, 1907, there were 18,000,000 barrels so held within the limits of these reservations.

The total quantity of crude petroleum run from wells on the Osage Nation during the year 1907 was 5,143,971 barrels, of which there was run to the Prairie Oil and Gas Company a total of 5,085,232 barrels; to the Uncle Sam Oil Company, 56,758 barrels; to the Superior Refining Company, 2,003 barrels, and sold to operators for fuel, 768 barrels.

In the following table is given a statement of the quantity of crude petroleum produced by the Indian Territory Illuminating Oil Company and its sublessees from wells in Osage Nation, Oklahoma, from 1903 to 1907, inclusive:

*Production of crude petroleum by the Indian Territory Illuminating Oil Company and its sublessees from January 1, 1903, to December 31, 1907.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| 1903 | 56, 905 | 1906 | 5, 219, 106 |
| 1904 | 652, 479 | 1907 | 5, 143, 971 |
| 1905 | 3, 421, 478 | | |

On December 31, 1907, there had been 1,271 wells drilled in the Osage Nation, 837 of which were producing oil, 71 were producing gas, and 363 were dry and exhausted wells, producing neither oil nor gas. On December 31, 1906, there had been 1,080 wells drilled on this reservation, of which 716 were producing oil; 66 were producing gas, and 298 were dry. This is an increase of 121 producing oil wells, 5 gas wells, and 65 dry and exhausted wells, a total of 191 wells drilled during the calendar year 1907.

In the following table is shown the number of wells drilled in the Osage Nation by the Indian Territory Illuminating Oil Company and its sublessees from 1903 to 1907, inclusive:

*Oil and gas wells in the Osage Reservation, 1903–1907.*

| Total wells completed to— | Completed. | Productive. | Gas. | Dry. |
|---|---|---|---|---|
| January 1, 1903 | 30 | 17 | 2 | 11 |
| December 31, 1904 | 361 | 243 | 21 | 97 |
| June 10, 1905 | 544 | 355 | 34 | 155 |
| December 31, 1905 | 704 | 462 | 45 | 197 |
| June 10, 1906 | 862 | 569 | 55 | 238 |
| December 31, 1906 | 1,080 | 716 | 66 | 298 |
| June 30, 1907 | 1,155 | 779 | 67 | 309 |
| December 31, 1907 | 1,271 | 837 | 71 | 363 |

*Estimated production and sales of crude petroleum from Glenn pool in 1907, by months.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| January | 385, 939 | August | 2, 003, 607 |
| February | 572, 414 | September | 2, 309, 205 |
| March | 1, 084, 636 | October | 2, 441, 622 |
| April | 1, 716, 079 | November | 1, 971, 595 |
| May | 1, 923, 262 | December | 1, 625, 127 |
| June | 1, 971, 122 | | |
| July | 1, 922, 387 | Total | 19, 926, 995 |

The following diagram shows the variations in production of the Glenn pool in 1907:

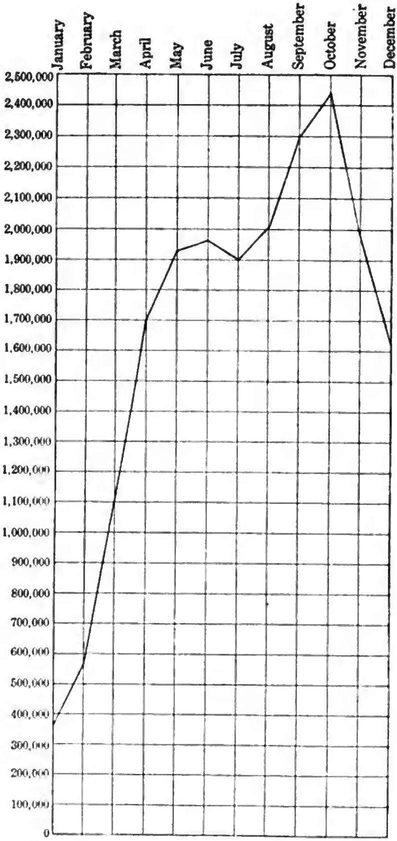

FIG. 5.—Rise and decline of the output of the Glenn pool in Oklahoma, in 1907, by months, in barrels.

*Well record.*—The following table gives the well record in Oklahoma in 1907, by districts:

*Well record in Oklahoma in 1907, by districts.*[a]

| District. | Wells drilled. | | | | |
|---|---|---|---|---|---|
| | Oil. | Total initial production. | Gas. | Dry. | Total. |
| Cherokee | 2,218 | 139,206 | 75 | 185 | 2,478 |
| Osage | 144 | 16,350 | 15 | 15 | 174 |
| Creek | 1,090 | 303,105 | 38 | 97 | 1,225 |
| Cleveland | 16 | 524 | 8 | 12 | 36 |
| Other | 12 | 500 | 13 | 18 | 47 |
| Total | 3,484 | 459,685 | 149 | 327 | 3,900 |

[a] Taken from Oil City Derrick.

## GULF FIELD.

Collectively the Gulf field, including the oil fields of Louisiana and coastal Texas (northern Texas excepted) showed a decline in total production, nevertheless new developments were sufficient to keep interest up to the level of 1906, as was shown by general activity in well drilling. As in the Mid-Continent field, the oil possibilities of Texas and Louisiana are by no means ascertained, and the probability lies on the side of the discovery of other highly productive areas.

In the Gulf field the accumulation of petroleum is determined by a type of geologic structure which is unique. The oil occurs in very recent rocks. All of these formations are characterized by flat or gently sloping strata, in which occur peculiar domes. These domes are perhaps uplifts, perhaps the results of the subterranean crystallization of soluble materials, salt, gypsum, and limestone, which have been brought up from relatively great depth and which may have elevated the strata above into their present position, forming these characteristic domes or "mounds," as they are called. Drilling on the top or sides of these mounds has frequently, as at Spindle Top, developed large oil gushers associated with salt water. Drilling only a short distance from the sides of these low domes shows a continuance of the surface formations to depths beyond the practical reach of the drill without finding any of the characteristics of the mound formations. There are many of these mounds, and they are attractive regions for drilling.

Most noteworthy in 1907 was the great gusher struck at Anse-la-Butte, in Louisiana, on account of its developing a field 40 miles east of Jennings.

### PRODUCTION.

In the following table is given the production of the Gulf field for the year 1907, by months.

*Production of crude petroleum in the Gulf field in 1907, by months, in barrels.*

| Month. | Coastal Texas. | Louisiana. | Total. |
|---|---|---|---|
| January | 876,816 | 589,200 | 1,466,016 |
| February | 888,161 | 434,465 | 1,322,626 |
| March | 1,124,648 | 380,863 | 1,505,511 |
| April | 1,115,721 | 294,777 | 1,410,498 |
| May | 1,005,233 | 251,962 | 1,257.195 |
| June | 935,933 | 227,960 | 1,163,893 |
| July | 903,816 | 365,032 | 1,268,848 |
| August | 933,839 | 469,208 | 1,403,047 |
| September | 873,213 | 428,392 | 1,301,605 |
| October | 871,852 | 326,679 | 1,198,531 |
| November | 895,759 | 587.294 | 1,483,053 |
| December | 985,087 | 644,389 | 1,629,476 |
| Total | 11,410,078 | 5,000,221 | 16,410,299 |

*Production of crude petroleum in the Gulf field, 1889–1907, by States, in barrels.*

| Year. | Coastal Texas. | Louisiana. | Total. |
|---|---|---|---|
| 1889 to 1900 | 2,441 | ............ | 2,441 |
| 1901 | 3,593,113 | ............ | 3,593,113 |
| 1902 | 17,465,787 | 548,617 | 18,014,404 |
| 1903 | 17,453,612 | 917,771 | 18,371,383 |
| 1904 | 21,672,311 | 2,958,958 | 24,631,269 |
| 1905 | 27,615,907 | 8,910,416 | 36,526,323 |
| 1906 | 11,449,992 | 9,077,528 | 20,527,520 |
| 1907 | 11,410,078 | 5,000,221 | 16,410,299 |

*Production and value of crude petroleum produced in the Gulf field, 1905–1907, in barrels.*

| Year. | Coastal Texas. |  | Louisiana. |  | Total. |  |
|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 27,615,907 | $7,190,658 | 8,910,416 | $1,601,325 | 36,526,323 | $8,791,983 |
| 1906 | 11,449,992 | 5,825,036 | 9,077,528 | 3,557,838 | 20,527,520 | 9,382,874 |
| 1907 | 11,410,078 | 9,680,286 | 5,000,221 | 4,063,033 | 16,410,299 | 13,743,319 |

In the following table is shown the production of crude petroleum in the Gulf field from 1889 to 1907 with its percentage of the total of the United States, the increase or decrease each year, and the percentage of increase or decrease:

*Production of crude petroleum in the Gulf field, 1889–1907, in barrels.*

| Year. | Production. | Percentage of total production. | Increase. | Decrease. | Percentage. |  |
|---|---|---|---|---|---|---|
|  |  |  |  |  | Increase. | Decrease. |
| 1889 | 48 | ...... | ........ | ........ | ........ | ........ |
| 1890 | 54 | ........ | 6 | ........ | 12.50 | ........ |
| 1891 | 54 | ........ | ........ | ........ | ........ | ........ |
| 1892 | 45 | ........ | ........ | 9 | ........ | 16.67 |
| 1893 | 50 | ........ | 5 | ........ | 11.11 | ........ |
| 1894 | 60 | ........ | 10 | ........ | 20.00 | ........ |
| 1895 | 50 | ........ | ........ | 10 | ........ | 16.67 |
| 1896 | 50 | ........ | ........ | ........ | ........ | ........ |
| 1897 | 50 | ........ | ........ | ........ | ........ | ........ |
| 1898 | 1,450 | ........ | 1,400 | ........ | 2,800.00 | ........ |
| 1899 | 530 | ........ | ........ | 920 | ........ | 63.45 |
| 1900 | 0 | ........ | ........ | 530 | ........ | 100.00 |
| 1901 | 3,593,113 | 5.18 | 3,593,113 | ........ | ........ | ........ |
| 1902 | 18,014,404 | 20.29 | 14,421,291 | ........ | 401.36 | ........ |
| 1903 | 18,371,383 | 18.29 | 356,979 | ........ | 1.98 | ........ |
| 1904 | 24,631,269 | 21.03 | 6,259,886 | ........ | 34.07 | ........ |
| 1905 | 36,526,323 | 27.11 | 11,895,054 | ........ | 48.29 | ........ |
| 1906 | 20,527,520 | 16.23 | ........ | 15,998,803 | ........ | 43.80 |
| 1907 | 16,410,299 | 9.88 | ........ | 4,117,221 | ........ | 20.05 |

## WELL RECORD.

In the following table will be found the number of wells completed in 1907 in the different districts of the Gulf field. Most of the well-record information of the Gulf field is compiled from the statistics of field operations published monthly by the Oil Investors' Journal, of Beaumont, Tex.

*Well record in Gulf field in 1907.*

| District. | Wells drilled. | | | | Abandoned. |
|---|---|---|---|---|---|
| | Total. | Oil. | Gas. | Dry. | |
| Coastal Texas: | | | | | |
| Humble | 269 | 170 | 10 | 89 | 156 |
| Batson | 206 | 174 | 0 | 32 | 31 |
| Spindle Top | 122 | 101 | 0 | 21 | 14 |
| Sour Lake | 156 | 120 | 1 | 35 | 26 |
| Saratoga | 98 | 86 | 0 | 12 | 11 |
| Dayton | 18 | 11 | 0 | 7 | 10 |
| Matagorda | 6 | 0 | 0 | 6 | 0 |
| Hoskins Mound | 6 | ........ | 2 | 4 | 3 |
| Piedras Pintas | 5 | 4 | 0 | 1 | 1 |
| Mission | 9 | 5 | ........ | 4 | ........ |
| Total | 895 | 671 | 13 | 211 | 252 |
| Louisiana: | | | | | |
| Jennings | 76 | 53 | 0 | 23 | 41 |
| Caddo | 23 | 8 | 11 | 4 | 9 |
| Anse-la-Butte | 4 | 2 | 0 | 2 | 0 |
| Welsh | 6 | 1 | 0 | 5 | 5 |
| Total | 109 | 64 | 11 | 34 | 55 |
| Grand total | 1,004 | 735 | 24 | 245 | 307 |

## TEXAS.

### PRODUCTION.

The production from the whole State of Texas decreased slightly from 12,567,897 barrels in 1906 to 12,322,696 barrels in 1907. This decline was most noticeable in the Humble, Batson, and Hoskins mounds. The most noted increase, amounting to 50 per cent, was at Spindle Top. In December the daily average at Spindle Top was greater than at any time since 1904. Sour Lake, Saratoga, Powell, and Henrietta also showed minor increases. Drilling was active in the Piedras Pintas and Mission fields. In northern Texas the showing was poor.

*Jack County.*—At Jacksboro, Jack County, are a few small wells which produce a fine grade of lubricating oil, about one barrel each per day. These wells are shallow, about 100 feet in depth. Deeper drilling is now in progress in this county. At a depth of 2,200 feet three sands showing oil were encountered, but they were full of salt water. Another well was started, but drilling operations have been suspended at a depth of 800 feet.

*Bexar County.*—During the year 1907 a new field was opened up near San Antonio, Bexar County, called the Mission oil field. Six wells have been completed, and others are in process of development. For many years a small quantity of oil of very fine grade has been produced from three wells in this locality. One well drilling in this locality to a depth of about 1,200 or 1,400 feet struck oil and gas in about every 100 feet; the drill penetrated small deposits of coal, sulphur rock, paraffin, and other strata indicating the presence of oil.

There is also a strong flow of gas. Work on this well has been temporarily suspended.

*Duval County.*—The discovery of crude petroleum in a well in Piedras Pintas, Duval County, in 1907, adds another oil field to this State. Four wells were completed; a portion of the product was shipped by rail, a portion was consumed in the field in development work, and a small quantity remained on hand at wells in the field at the close of the year. Developments are in progress.

In addition to the oil districts mentioned it is reported that developments are in progress in Montague, Denton, Lamar, Cass, Hunt, Kaufman, and Wise counties.

*Production of crude petroleum in northern and coastal Texas in 1906 and 1907, by months, in barrels.*

| Month. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Northern Texas. | Coastal Texas. | Total. | Northern Texas. | Coastal Texas. | Total. |
| January | 54,460 | 1,129,230 | 1,183,690 | 95,270 | 876,816 | 972,086 |
| February | 62,283 | 915,192 | 977,475 | 90,527 | 888,161 | 978,688 |
| March | 70,036 | 914,074 | 984.110 | 96,188 | 1,124,648 | 1,220,836 |
| April | 80,452 | 937,277 | 1,017,729 | 86,311 | 1,115.721 | 1,202,032 |
| May | 97,976 | 1,089,744 | 1,187,720 | 84,333 | 1,005,233 | 1,089,566 |
| June | 107,160 | 1,141,078 | 1,248,238 | 82,297 | 935,933 | 1,018,230 |
| July | 114,137 | 1,069,925 | 1,184,062 | 67,552 | 903,816 | 971,368 |
| August | 111,456 | 925.666 | 1,037,122 | 66,805 | 933,839 | 1,000,644 |
| September | 109,102 | 806,274 | 915,376 | 60,229 | 873,213 | 933,442 |
| October | 113,775 | 872,207 | 985,982 | 62,059 | 871,852 | 933,911 |
| November | 98,265 | 812,048 | 910,313 | 55,656 | 895,759 | 951,415 |
| December | 98,803 | 837,277 | 936,080 | 65,391 | 985,087 | 1,050,478 |
| Total | 1,117,905 | 11,449,992 | 12,567,897 | 912,618 | 11,410,078 | 12,322,696 |

*Production and value of crude petroleum produced in northern and coastal Texas, 1905–1907, in barrels.*

| Year. | Northern Texas. | | Coastal Texas. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 520,282 | $361,604 | 27,615,907 | $7,190,658 | 28,136,189 | $7,552,262 |
| 1906 | 1,117,905 | 740,542 | 11,449,992 | 5,825,036 | 12,567.897 | 6,565,578 |
| 1907 | 912,618 | 721,577 | 11,410,078 | 9,680,286 | 12,322,696 | 10,401,863 |

In the two following tables will be found the production of crude petroleum in Texas, by districts and months, for the years 1906 and 1907:

*Production of crude petroleum in Texas, 1906–7, by districts and months, in barrels.*

1906.

| Month. | Spindle Top. | Sour Lake. | Batson. | Saratoga. | Corsicana. | Powell. |
|---|---|---|---|---|---|---|
| January | 113,180 | 225,083 | 214,926 | 148,183 | 26,686 | 17,470 |
| February | 121,609 | 185,441 | 206,942 | 139,946 | 30,232 | 21,872 |
| March | 75,014 | 193,183 | 206,991 | 173,159 | 28,330 | 31,640 |
| April | 77,398 | 202,781 | 202,410 | 162,189 | 26,541 | 43,915 |
| May | 99,096 | 196,479 | 207,460 | 208,417 | 28,260 | 59,779 |
| June | 78,259 | 183,608 | 191,733 | 193,645 | 27,103 | 71,198 |
| July | 78,069 | 177,933 | 198,675 | 188,608 | 26,858 | 78,083 |
| August | 71,477 | 154,138 | 194,528 | 183,941 | 26,204 | 76,242 |
| September | 77,044 | 135,910 | 171,837 | 180.740 | 27,926 | 72.228 |
| October | 88,662 | 186,001 | 171,605 | 208,906 | 30,275 | 74,786 |
| November | 95,687 | 148,984 | 149,837 | 201,882 | 24.377 | 65,253 |
| December | 101,997 | 166,469 | 172,563 | 192,441 | 29,830 | 60,755 |
| Total | 1,077,492 | 2,156,010 | 2,289,507 | 2,182,057 | 332,622 | 673,221 |

*Production of crude petroleum in Texas, 1906–7, by districts and months, in barrels*—Continued.

1906—Continued.

| Month. | Humble. | Matagorda and Hoskins Mound. | Henrietta. | Dayton. | Other. | Total. |
|---|---|---|---|---|---|---|
| January | 413,117 | 300 | 10,221 | 14,439 | ............ | 1,183,690 |
| February | 250,731 | 300 | 10,096 | 10,221 | ............ | 977,475 |
| March | 256,756 | 300 | 9,983 | 8,669 | ............ | 984,110 |
| April | 285,627 | 300 | 9,913 | 6,570 | ............ | 1,017,729 |
| May | 359,521 | 9,687 | 9,854 | 9,082 | ............ | 1,187,720 |
| June | 448,871 | 38,870 | 8,776 | 6,090 | ............ | 1,248,238 |
| July | 406,579 | 14,004 | 9,113 | 6,055 | ............ | 1,184,062 |
| August | 306,309 | 9,422 | 8,927 | 5,849 | ............ | 1,037,122 |
| September | 233,422 | 2,460 | 8,865 | 4,859 | ............ | 915,376 |
| October | 210,748 | 1,523 | 8,631 | 4,760 | ............ | 985,982 |
| November | 209,041 | 1,785 | 8,552 | 4,830 | ............ | 910,313 |
| December | 190,723 | 1,640 | 8,141 | 11,426 | ............ | 936,090 |
| Total | 3,571,445 | 80,591 | 111,072 | 92,850 | [a] 1,030 | 12,567,897 |

1907.

| Month. | Spindle Top. | Sour Lake. | Batson. | Saratoga. | Corsicana. | Powell. |
|---|---|---|---|---|---|---|
| January | 113,293 | 176,808 | 186,128 | 192,680 | 27,469 | 61,349 |
| February | 112,010 | 193,891 | 172,808 | 219,918 | 21,562 | 59,985 |
| March | 174,956 | 247,062 | 225,097 | 225,219 | 21,455 | 64,379 |
| April | 158,949 | 238,690 | 169.640 | 210,693 | 21,087 | 59,601 |
| May | 142,085 | 213,612 | 200,382 | 168,557 | 18,230 | 60,018 |
| June | 135,845 | 184,683 | 206,216 | 165,989 | 17,464 | 58,405 |
| July | 134,190 | 200,226 | 173,173 | 164,874 | 15,282 | 45,681 |
| August | 132,431 | 214,056 | 181,660 | 154,774 | 17,165 | 42,008 |
| September | 122,676 | 196,877 | 155.007 | 148,186 | 14,158 | 38,145 |
| October | 121,829 | 165,934 | 156,730 | 164,994 | 16,598 | 37,454 |
| November | 153,586 | 162,553 | 168,888 | 156,167 | 13,438 | 34,569 |
| December | 198,093 | 159,548 | 168.724 | 158.877 | 22,403 | 35,303 |
| Total | 1,699,943 | 2,353,940 | 2,164,453 | 2.130,928 | 226,311 | 596,897 |

| Month. | Humble. | Matagorda and Hoskins Mound. | Henrietta. | Dayton. | Other. | Total. |
|---|---|---|---|---|---|---|
| January | 189,138 | 3,739 | 6,240 | 15,024 | 218 | 972,086 |
| February | 180,307 | 427 | 8,668 | 8,794 | 318 | 978,688 |
| March | 237,217 | 1,593 | 9,992 | 13,498 | 368 | 1,220,836 |
| April | 326,013 | 948 | 5,211 | 10,782 | 418 | 1,202,032 |
| May | 270,547 | 2,080 | 5,613 | 7,964 | 478 | 1,089,566 |
| June | 230,581 | 779 | 5,916 | 10,640 | 1,712 | 1,018,230 |
| July | 217,812 | 1,683 | 6,077 | 10,658 | 1,712 | 971,368 |
| August | 239,483 | 100 | 7,120 | 10,135 | 1,712 | 1,000,644 |
| September | 240,895 | 564 | 7,414 | 7,808 | 1,712 | 933,442 |
| October | 254,865 | 444 | 7,245 | 5,343 | 2,475 | 933,911 |
| November | 249,619 | 300 | 6,877 | 2,933 | 2,485 | 951,415 |
| December | 293,163 | 610 | 6,887 | 4,459 | 2,411 | 1,050,478 |
| Total | 2,929,640 | 13,267 | 83,260 | 108,038 | [b] 16,019 | 12,322,696 |

[a] Includes production in Bexar, Jack, and McLennan counties.
[b] Includes production of Mission, Piedras Pintas, South Bosque and Jack County districts.

The production of petroleum in Texas from 1896 to 1907, inclusive, has been as follows:

*Production of crude petroleum in Texas, 1896–1907, by districts, in barrels.*

| Year. | Corsicana. | Powell. | Spindle Top. | Sour Lake. | Saratoga. | Batson. | Dayton. | Matagorda. | Henrietta. | Humble. | Other. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1896 | 1,450 | | | | | | | | | | | 1,450 |
| 1897 | 65,975 | | | | | | | | | | | 65,975 |
| 1898 | 544,620 | | | | | | | | | | 1,450 | 546,070 |
| 1899 | 668,483 | | | | | | | | | | 530 | 669,013 |
| 1900 | 829,560 | 6,479 | | | | | | | | | | 836,039 |
| 1901 | 763,424 | 37,121 | 3,593,113 | | | | | | | | | 4,393,658 |
| 1902 | 571,059 | 46,812 | 17,420,949 | 44,838 | | | | | | | | 18,083,658 |
| 1903 | 401,817 | 100,143 | 8,600,905 | 8,848,159 | | 4,518 | | | | | 30 | 17,955,572 |
| 1904 | 374,318 | 129,329 | 3,433,842 | 6,442,357 | 739,239 | 10,904,737 | | 151,936 | 65,455 | | 200 | 22,241,413 |
| 1905 | 311,554 | 132,866 | 1,652,780 | 3,362,153 | 3,125,028 | 3,774,841 | 60,294 | 46,471 | 75,592 | 15,594,310 | 309 | 28,136,189 |
| 1906 | 332,622 | 673,221 | 1,077,492 | 2,156,010 | 2,182,057 | 2,289,507 | 92,850 | [a] 80,591 | 111,072 | 3,571,445 | 1,030 | 12,567,897 |
| 1907 | 226,311 | 596,897 | 1,699,943 | 2,353,940 | 2,130,928 | 2,164,453 | 108,038 | [a] 13,267 | 83,260 | 2,929,640 | 16,019 | 12,322,696 |

[a] Includes the production of Hoskins Mound.

The following table gives a statement of the production and value of crude petroleum at wells in Texas in 1906 and 1907, by districts:

*Production and value of petroleum in Texas in 1906 and 1907, by districts, in barrels.*

| District. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Price per barrel. | Quantity. | Value. | Price per barrel. |
| Spindle Top | 1,077,492 | $666,287 | $0.618 | 1,699,943 | $1,521,304 | $0.895 |
| Sour Lake | 2,156,010 | 1,155,475 | .536 | 2,353,940 | 1,944,343 | .826 |
| Saratoga | 2,182,057 | 985,543 | .45 | 2,130,928 | 1,742,913 | .818 |
| Corsicana | 332,622 | 310,941 | .935 | 226,311 | 228,845 | 1.011 |
| Powell | 673,221 | 356,144 | .529 | 596,897 | 407,186 | .682 |
| Batson | 2,289,507 | 1,199,625 | .524 | 2,164,453 | 1,913,875 | .884 |
| Humble | 3,571,445 | 1,736,165 | .486 | 2,929,640 | 2,456,892 | .839 |
| Dayton | 92,850 | 40,265 | .434 | 108,038 | 80,559 | .746 |
| Henrietta | 111,072 | 72,197 | .65 | 83,260 | 78,946 | .948 |
| Matagorda | [a] 80,591 | 41,556 | .516 | [a] 13,267 | 10,811 | .815 |
| Other | 1,030 | 1,380 | 1.34 | 16,019 | 16,189 | 1.011 |
| Total | 12,567,897 | 6,565,578 | .522 | 12,322,696 | 10,401,863 | .844 |

[a] Includes the production of Hoskins Mound.

## PRICES.

Average monthly prices of crude petroleum per barrel of 42 gallons at wells in the Texas field in the years 1906 and 1907 were as follows:

*Average monthly prices of crude petroleum in Texas in 1906 and 1907.*

| Month. | Spindle Top. | | Sour Lake. | | Humble. | | Batson. | | Saratoga. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. |
| January | $0.51-$0.52 | $0.72-$0.78 | $0.41½ - $0.464 | $0.65½-$0.76 | $0.35 - $0.40 | $0.62-$0.77 | $0.31½ - $0.40 | $0.72-$0.75 | $0.32½-$0.35 | $0.66-$0.75 |
| February | .52- .54 | .78- .80 | .40 - .46 | .72 - .80 | .34 - .3959 | .69- .80 | .30 - .40 | .77- .80 | .31 - .32 | .69- .80 |
| March | .57- .60 | .81- .85 | .42 - .50 | .74 - .85 | .364 - .40 | .74- .90 | .34 - .46 | .80- .85 | .335- .36 | .72- .85 |
| April | .59- .62 | .83- .87½ | .43 - .55 | .79 - .90 | .40 - .44 | .76- .90 | .385 - .50 | .81- .85 | .30 - .39 | .75- .85 |
| May | .62- .65 | .83- .89 | .45 - .584 | .79 - .90 | .44 - .484 | .76- .91 | .40 - .55 | .82- .90 | .305- .42 | .78- .90 |
| June | .64- .65 | .85- .93 | .45 - .60 | .79 - .90 | .465 - .514 | .76- .94 | .42 - .55 | .81- .93 | .30 - .44 | .78- .93 |
| July | .65 | .88- .95 | .45 - .60 | .80 - .93 | .48 - .52 | .80- .95 | .43 - .55 | .88- .93 | .29 - .475 | .81- .93 |
| August | .65 | .93- .97 | .45 - .6168 | .88 - .93 | .5066- .54 | .81- .99 | .4566- .55 | .92- .93 | .34 - .51 | .84- .93 |
| September | .65- .67 | .94- .97 | .50 - .634 | .89 - .97 | .52 - .60 | .81- .97 | .48 - .575 | .92- .95 | .39 - .57 | .85- .92 |
| October | .66- .68 | .94- .98 | .57 - .64 | .84 - .97 | .53 - .65 | .82- .97 | .495 - .605 | .92- .95 | .44 - .58 | .80- .94 |
| November | .68- .73 | .85- .97 | .6355- .70 | .79 - .97 | .53 - .75 | .77- .95 | .62 - .65 | .92- .95 | .51 - .655 | .75- .92 |
| December | .70- .75 | .70- .97 | .67 - .73 | .78 - .97 | .54 - .75 | .70- .95 | .70 - .75 | .88- .95 | .56 - .75 | .74- .94 |
| Average | .618 | .895 | .536 | .826 | .486 | .839 | .524 | .884 | .45 | .818 |

| Month. | Dayton. | | Corsicana. | | Powell. | | Henrietta. | | Matagorda. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. |
| January | $0.31 | $0.65-$0.69 | $0.89 | $1.00 | $0.50 | $0.65 | $0.65 | $0.95 | $0.85 | $1.00 |
| February | .29 | .65- .73 | .89 | $1.00- 1.02 | .50 | .65 | .65 | .95 | .85 | 1.00 |
| March | .29 | .73 | .89 | 1.02 | .50 | .70 | .65 | .95 | .85 | 1.00 |
| April | .35 | .73 | $0.89- .91 | 1.02 | $0.50- .52 | .70 | .65 | .95 | .85 | 1.00 |
| May | .37 | .73 | .91 | 1.02 | .52 | .70 | .65 | .95 | .85 | 1.00 |
| June | .40 | .75 | .91 | 1.02 | .52 | .70 | .65 | .95 | .85 | 1.00 |
| July | .46 | .75 | .89- .91 | 1.02 | .50- .52 | .70 | .65 | .95 | .85 | 1.00 |
| August | .47 | .76 | .89 | 1.02 | .50 | .70 | .65 | .95 | .85 | 1.00 |
| September | .50 | .86 | .89- 1.00 | 1.02 | .50- .55 | .70 | .65 | .95 | .85 | 1.00 |
| October | .51 | .85 | 1.00 | 1.02 | .55- .60 | .70 | .65 | .95 | .85 | 1.00 |
| November | .56 | .84 | 1.00 | 1.02 | .60 | .70 | .65 | .95 | .85 | 1.00 |
| December | .65 | .72 | 1.00 | 1.02 | .60 | .70 | .65 | .93 | .85 | 1.00 |
| Average | .434 | .746 | .935 | 1.011 | .529 | .682 | .65 | .948 | .85 | 1.00 |

*Prices of Corsicana and Powell oil.*—The following tables show the prices of Corsicana and Powell oil from 1904 to 1907, inclusive:

*Fluctuations in prices of Corsicana light oil, 1904–1907, per barrel.*

| Date | Price |
|---|---|
| **1904.** | |
| January 1 | $1.27 |
| January 12 | 1.17 |
| January 20 | 1.07 |
| February 12 | 1.02 |
| March 1 | .99 |
| March 4 | .96 |
| March 12 | .93 |
| March 29 | .90 |
| April 8 | .87 |
| April 29 | .84 |
| June 7 | .81 |
| June 17 | .78 |
| **1904—Continued.** | |
| July 9 | $0.73 |
| July 13 | .70 |
| August 12 | .80 |
| September 1 | .85 |
| **1905.** | |
| January 5 | .82 |
| May 27 | .81 |
| September 12 | .83 |
| September 16 | .85 |
| September 19 | .87 |
| September 28 | .89 |
| **1905—Continued.** | |
| October 20 | $0.91 |
| November 11 | .89 |
| **1906.** | |
| April 25 | .91 |
| July 28 | .89 |
| September 12 | 1.00 |
| **1907.** | |
| January 1 | 1.00 |
| February 11 | 1.02 |
| December 1 | 1.00 |

*Fluctuations in prices of Powell heavy oil, 1904–1907, per barrel.*

| Date | Price |
|---|---|
| **1904.** | |
| January 1 | $0.55 |
| January 12 | .45 |
| January 20 | .40 |
| August 12 | .45 |
| September 1 | .50 |
| **1905.** | |
| Year | .50 |
| **1906.** | |
| April 25 | $0.52 |
| July 28 | .50 |
| September 12 | .55 |
| October 29 | .60 |
| **1907.** | |
| January 1 | $0.65 |
| January 26 | .70 |

*Well record in Corsicana and Powell districts.*—The following tables show the well record in the Corsicana and Powell districts:

*Well record in Corsicana and Powell oil districts in 1907, by months.*

| Month. | Wells. | | | | |
|---|---|---|---|---|---|
| | Completed. | Producing. | Gas. | Dry. | Abandoned. |
| January | 19 | 9 | 2 | 8 | [a] 2 |
| February | 14 | 9 | | 5 | 4 |
| March | 16 | 12 | | 4 | 0 |
| April | 14 | 9 | | 5 | 1 |
| May | 9 | 6 | | 3 | 1 |
| June | 10 | 7 | | 3 | 5 |
| July | 10 | 6 | | 4 | 0 |
| August | 12 | 5 | | 7 | 4 |
| September | 5 | 1 | | 4 | 3 |
| October | 11 | 7 | 2 | 2 | 3 |
| November | 4 | 0 | 0 | 4 | 0 |
| December | 5 | 0 | 2 | 3 | 1 |
| Total | 129 | 71 | 6 | 52 | 24 |

[a] One abandoned well was a gas well.

*Well record in the Corsicana and Powell oil districts, 1898–1907.*

| Year. | Wells. | | | | | | | Rigs. | |
|---|---|---|---|---|---|---|---|---|---|
| | Completed. | Producing. | Dry. | Gas. | Abandoned. | Drilling. | | Total. | Monthly average. |
| | | | | | | Total. | Monthly average. | | |
| 1898 | 374 | 342 | [a] 28 | 4 | 7 | 164 | 13 | 136 | 11 |
| 1899 | 268 | 169 | [a] 90 | 9 | 79 | 154 | 13 | 95 | 8 |
| 1900 | 373 | [b] 261 | [a] 98 | 14 | 112 | 157 | 13 | 80 | 7 |
| 1901 | 68 | [c] 47 | 16 | 5 | 27 | 51 | 4 | 47 | 4 |
| 1902 | 28 | [d] 12 | 13 | 3 | 45 | 23 | 2 | 46 | 4 |
| 1903 | 100 | 70 | 23 | 7 | 51 | 65 | 5 | 35 | 3 |
| 1904 | 74 | 46 | 25 | 3 | 31 | 23 | 2 | 17 | 1 |
| 1905 | 68 | 48 | 18 | 2 | 41 | 25 | 2 | 23 | 2 |
| 1906 | 330 | 217 | 100 | 13 | 79 | ........ | ........ | ........ | ........ |
| 1907 | 129 | 71 | 52 | 6 | 24 | ........ | ........ | ........ | ........ |

[a] Includes 2 artesian wells.
[b] Includes 56 wells in heavy oil district.
[c] Includes 10 wells in heavy oil district.
[d] Includes 2 wells in heavy oil district.

*Well record in Henrietta district.*—The following table shows the well record in the Henrietta district:

*Well record in Henrietta oil district in 1907, by months.*

| Month. | Wells. | | | | |
|---|---|---|---|---|---|
| | Completed. | Producing. | Gas. | Dry. | Abandoned. |
| January | | | ........ | ........ | ........ |
| February | | | ........ | ........ | ........ |
| March | 1 | 1 | ........ | ........ | ........ |
| April | 0 | .. | ........ | ........ | ........ |
| May | 3 | 2 | 0 | 1 | 0 |
| June | 6 | 4 | 0 | 2 | 0 |
| July | 4 | 2 | 0 | 2 | 0 |
| August | 2 | 2 | 0 | 0 | 3 |
| September | 4 | 2 | 0 | 2 | 0 |
| October | 2 | 0 | 1 | 1 | 0 |
| November | 0 | 0 | 0 | 0 | 0 |
| December | 5 | 4 | 0 | 1 | 0 |
| Total | 27 | 17 | 1 | 9 | 3 |

At the close of the year 1907 there was a total of 169 productive oil wells in the Henrietta, Clay County, oil field. The crude oil production of this field is piped from the field by the Navarro Refining Company, which succeeded the Claco Oil and Pipe Line Company on April 1, 1907. The product is used for fuel purposes. In October of 1907 a good gas well was brought in in this field by the Claco Oil and Pipe Line Company.

*Fluctuation in prices of Henrietta crude oil in 1907, per barrel.*

| | |
|---|---|
| January 1 | $0.95 |
| December 1 | .93 |

## SHIPMENTS.

In the following table is given the shipment of crude petroleum by railroad in tank cars from the different stations of Texas during the year 1907:

*Quantity of crude petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the year 1907, in barrels.*

| Month. | Spindle Top. | Sour Lake. | Humble and Trice. | Saratoga. | Danbury and Duval. | Total. |
|---|---|---|---|---|---|---|
| January | 57,625 | 55,143 | 269,729 | 39,668 | 4,136 | 426,301 |
| February | 53,038 | 172,832 | 271,957 | 22,554 | 371 | 520,752 |
| March | 18,612 | 169,300 | 217,699 | 150,858 | 1,698 | 558,167 |
| April | 19,801 | 173,074 | 275,548 | 44,552 | 964 | 513,939 |
| May | 25,532 | 252,361 | 160,833 | 206,762 | 2,250 | 647,738 |
| June | 24,822 | 235,631 | 225,583 | 106,884 | 771 | 593,691 |
| July | 18,324 | 151,085 | 241,651 | 153,535 | 1,798 | 566,393 |
| August | 44,904 | 115,184 | 181,019 | 136,271 | ........ | 477,378 |
| September | 28,186 | 132,095 | 188,532 | 130,396 | 528 | 479,737 |
| October | 15,969 | 247,205 | 197,707 | 111,080 | 391 | 572,352 |
| November | 18,278 | 193,304 | 210,389 | 123,955 | 932 | 546,858 |
| December | 5,232 | 173,606 | 158,718 | 142,465 | 383 | 480,404 |
| Total | 330,323 | 2,070,820 | 2,599,365 | 1,368,980 | 14,222 | 6,383,710 |

NOTE.—These are the official figures furnished by the railroads which shipped the crude petroleum Calculations were made in reduction of pounds to barrels on the basis of 310.8 pounds to a barrel.

*Shipments of petroleum from Port Arthur and Sabine Pass in 1907, by months, and total for year 1906, in barrels.*[a]

| Month. | Crude. | Refined. | Asphalt. | Total. |
|---|---|---|---|---|
| January | 395,537 | 349,008 | 22,444 | 766,989 |
| February | 327,318 | 404,016 | 26,262 | 757,596 |
| March | 463,165 | 358,815 | 20,584 | 842,564 |
| April | 403,903 | 369,108 | 10,172 | 783,183 |
| May | 440,183 | 228,631 | 2,049 | 670,863 |
| June | 321,777 | 387,159 | 23,863 | 732,799 |
| July | 432,076 | 441,847 | 1,726 | 875,649 |
| August | 517,372 | 442,680 | 32,764 | 992,816 |
| September | 273,476 | 278,378 | 1,529 | 553,383 |
| October | 304,752 | 370,285 | 31,688 | 706,725 |
| November | 181,312 | 493,753 | 888 | 675,953 |
| December | 300,146 | 383,320 | 11,446 | 694,912 |
| Total 1907 | 4,361,017 | 4,507,000 | 185,415 | 9,053,432 |
| Total 1906 | 6,223,628 | 4,521,082 | (b) | 10,744,710 |

[a] Figures taken from Oil Investors' Journal.
[b] Included in refined.

## EXPORTS.

The following tables, furnished by the Bureau of Statistics, Department of Commerce and Labor, give the exports of crude petroleum and its products from Texas, by months and kinds and by customs districts:

*Exports to foreign countries of crude and refined petroleum from all ports of Texas in 1907, by months, in gallons.*

| Month. | Crude. | | Naphtha. | | Illuminating. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| January | 1,243,570 | $62,314 | 5,121 | $662 | 1,225,836 | $67,516 |
| February | 3,575,603 | 178,263 | 30,923 | 5,307 | 1,793,545 | 117,043 |
| March | 797,964 | 14,319 | 9,072 | 1,282 | 83,174 | 11,484 |
| April | 22,593 | 818 | 5,708 | 737 | 1,472,531 | 77,434 |
| May | 19,151 | 585 | 2,265 | 309 | 29,254 | 3,333 |
| June | 5,290 | 265 | 3,247 | 432 | 23,075 | 4,531 |
| July | 20,100 | 530 | 1,868 | 208 | 13,545 | 2,803 |
| August | 1,693,736 | 46,616 | 10,388 | 4,974 | 2,306,994 | 110,614 |
| September | 906,953 | 25,459 | 2,036 | 316 | 1,723,941 | 90,432 |
| October | 1,821,392 | 50,342 | 2,730 | 429 | 1,658,078 | 97,146 |
| November | ........ | ........ | 5,816 | 938 | 3,830,963 | 187,261 |
| December | 2,636,566 | 76,951 | 1,616 | 257 | 2,826,983 | 129,302 |
| Total | 12,742,918 | 456,462 | 80,790 | 15,941 | 16,987,919 | 898,399 |

| Month. | Residuum. | | Lubricating and paraffin. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| January | ........ | ........ | 48,500 | $9,409 | 2,523,027 | $139,901 |
| February | 1,473,585 | $44,208 | 41,330 | 6,943 | 6,914,986 | 351,764 |
| March | 1,163,011 | 26,168 | 53,190 | 8,902 | 2,106,411 | 62,155 |
| April | 939,988 | 31,837 | 1,029,232 | 83,153 | 3,470,052 | 193,979 |
| May | 4,741,764 | 149,048 | 23,033 | 3,524 | 4,815,467 | 156,799 |
| June | 1,002,609 | 35,091 | 481,173 | 38,154 | 1,515,394 | 78,473 |
| July | 2,112,563 | 73,940 | 1,033,890 | 77,896 | 3,181,966 | 154,967 |
| August | 6,285,277 | 206,662 | 18,341 | 3,439 | 10,314,736 | 372,305 |
| September | 2,000,260 | 70,026 | 9,120 | 2,899 | 4,642,310 | 189,132 |
| October | 2,038,976 | 71,334 | 21,054 | 3,820 | 5,542,230 | 223,071 |
| November | 3,336,734 | 118,317 | 9,474 | 2,042 | 7,182,987 | 308,558 |
| December | 1,226,298 | 44,473 | 180,475 | 19,444 | 6,871,938 | 270,427 |
| Total | 26,321,065 | 871,104 | 2,948,812 | 259,625 | 50,081,504 | 2,501,531 |

*Exports of crude and refined petroleum from Texas, by customs districts, in 1907, in gallons.*

| Kind. | Brazos de Santiago. | | Corpus Christi. | | Galveston. | | Sabine. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Crude, including all natural oils | ........ | ........ | 35,347 | $1,480 | 4,821,699 | $241,238 | 7,734,154 | $207,777 |
| Refined: | | | | | | | | |
| Naphthas | ........ | ........ | 19,793 | 6,356 | 50 | 12 | ........ | ........ |
| Illuminating | 26,567 | $4,037 | 180,210 | 26,213 | 2,872,830 | 163,975 | 13,721,558 | 672,564 |
| Lubricating and heavy paraffin | 140 | 29 | 103,120 | 19,673 | 30,225 | 5,835 | 2,660,449 | 206,944 |
| Residuum, etc | ........ | ........ | 433 | 20 | 1,473,585 | 44,208 | 24,845,887 | 826,760 |
| Total | 26,707 | 4,066 | 338,903 | 53,742 | 9,198,389 | 455,268 | 48,962,048 | 1,914,045 |

| Kind. | Paso del Norte. | | Saluria. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Crude, including all natural oils | ........ | ........ | 151,718 | $5,967 | 12,742,918 | $456,462 |
| Refined: | | | | | | |
| Naphthas | 48,936 | $7,829 | 12,011 | 1,744 | 80,790 | 15,941 |
| Illuminating | 58,329 | 6,375 | 128,425 | 25,235 | 16,987,919 | 898,399 |
| Lubricating and heavy paraffin | 99,383 | 17,142 | 55,495 | 10,002 | 2,948,812 | 259,625 |
| Residuum, etc | 1,160 | 116 | ........ | ........ | 26,321,065 | 871,104 |
| Total | 207,808 | 31,462 | 347,649 | 42,948 | 50,081,504 | 2,501,531 |

## LOUISIANA.

*Anse-la-Butte.*—The feature of chief importance in development in the Louisiana petroleum fields in 1907 was the drilling, on November 14, of a gusher at Anse-la-Butte, 40 miles east of Jennings. The well began spouting at the rate of about 3,000 barrels a day, which rate increased for several days, when the well stopped and then began to spout salt water and oil. This has kept up very persistently, the flow at the end of the year being estimated at 650 barrels of oil per day.

The conditions at Anse-la-Butte are those usually found in the Gulf field—a "mound" in this case surrounded by marshy territory in which oil and gas seepages are common and have led to efforts for the development of the field since 1893. The work of Capt. A. F. Lucas in 1900 and 1901 called especial attention to the field, and over 30 wells have been drilled in the neighborhood, of which a few have yielded small supplies of oil. Captain Lucas drilled 3 test wells only a few hundred feet west of the present gusher, which is known as the Lake Oil Company's No. 7. The wells of Captain Lucas did not go to the limit in depth; they yielded considerable shallow oil and gas. The Maresi Brothers, of Jeanerette, followed the work of Captain Lucas with 5 wells. Mr. Robert Martin and the Heywood Brothers have drilled 11 wells and are continuing. The Lake Oil Company, of which Mr. Walter J. Barke, of New Iberia, is president, subleased oil land from the Anse-la-Butte le Danois Oil Company. Of the 7 wells drilled, Nos. 2 and 6 are producers at 30 to 40 barrels per day. Rock salt and gypsum have been frequently found. No. 4, located 300 feet south of No. 7, went into salt and gypsum at 500 feet, and was still in it when drilling was stopped at 2,187 feet. The log of No. 7, which proved saprolific, shows no salt or gypsum, but thick strata of gumbo clay, and the formations are much less broken.

An analysis of the oil as reported by the Lake Oil Company is as follows: Color, black; specific gravity, 0.9174, or 22.6° B.; flash, 30° F.; sulphur, 0.31. By distillation the oil yields 16 per cent of illuminating oil between 150° and 300° C., and 75.4 per cent above 300° C., with 7 per cent residue, and 1.6 per cent loss.

*Jennings.*—The Jennings field was extended to the southeast by the Producers' Oil Company and to the southwest by the Jennings-Heywood Syndicate.

*Caddo.*—Twenty-three wells were completed in this district, of which 8 produced oil, 11 produced gas, and 4 were dry. The district was considerably extended, and the indications point to much more substantial developments than indicated by the 1907 production, which showed an increase to 44,908 barrels from only 3,358 barrels in 1906.

## PRODUCTION, VALUE, AND SHIPMENTS OF LOUISIANA PETROLEUM.

In the following table will be found the quantity of crude petroleum produced in Louisiana in 1906 and 1907, by months:

*Production of petroleum in Louisiana in 1906 and 1907, by months, in barrels.*

| Month. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Jennings. | Other. | Total. | Jennings. | Other. | Total. |
| January | 701, 357 | 2, 830 | 704, 187 | 578, 705 | 10, 495 | 589, 200 |
| February | 676, 066 | 2, 830 | 678, 896 | 427, 791 | 6, 674 | 434, 465 |
| March | 743, 197 | 2, 830 | 746, 027 | 373, 802 | 7, 061 | 380, 863 |
| April | 702, 469 | 2, 830 | 705, 299 | 286, 465 | 8, 312 | 294, 777 |
| May | 1, 074, 917 | 4, 092 | 1, 079, 009 | 246, 066 | 5, 896 | 251, 962 |
| June | 1, 000, 854 | 7, 763 | 1, 008, 617 | 222, 260 | 5, 700 | 227, 960 |
| July | 719, 353 | 4, 069 | 723, 422 | 357, 348 | 7, 684 | 365, 032 |
| August | 835, 465 | 3, 935 | 839, 400 | 457, 679 | 11, 529 | 469, 208 |
| September | 699, 051 | 4, 763 | 703, 814 | 416, 562 | 11, 830 | 428, 392 |
| October | 744, 778 | 3, 218 | 747, 996 | 318, 845 | 7, 834 | 326, 679 |
| November | 614, 242 | 4, 759 | 619, 001 | 575, 343 | 11, 951 | 587, 294 |
| December | 513, 425 | 8, 435 | 521, 860 | 635, 039 | 9, 350 | 644, 389 |
| Total | 9, 025, 174 | 52, 354 | 9, 077, 528 | 4, 895, 905 | 104, 316 | 5, 000, 221 |

In the following table is given a statement of production and value of crude petroleum in Louisiana, 1902 to 1907, by fields:

*Production and value of petroleum in Louisiana, 1902–1907, by districts, in barrels.*

| Year. | Jennings. | | Welsh. | | Anse-la-Butte. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 548, 617 | $188, 985 | | | | | 548, 617 | $188, 985 |
| 1903 | 892, 609 | 391, 066 | 25, 162 | $25, 162 | | | 917, 771 | 416, 228 |
| 1904 | 2, 923, 066 | 1, 049, 144 | 35, 892 | 24, 450 | | | 2, 958, 958 | 1, 073, 594 |
| 1905 | 8, 891, 416 | 1, 589, 825 | 10, 000 | 7, 500 | 9, 000 | $4, 000 | 8, 910, 416 | 1, 601, 325 |
| 1906 | 9, 025, 174 | 3, 525, 879 | 23, 996 | 17, 405 | [a] 28, 358 | 14, 554 | 9, 077, 528 | 3, 557, 838 |
| 1907 | 4, 895, 905 | 3, 982, 043 | 47, 316 | 35, 127 | [a] 57, 000 | 45, 863 | 5, 000, 221 | 4, 063, 033 |

[a] Includes the production of Caddo district.

*Average monthly price of crude petroleum per barrel at wells in the Jennings and Caddo oil districts, 1904–1907.*

| Month. | Jennings. | | | | Caddo, 1907. |
|---|---|---|---|---|---|
| | 1904. | 1905. | 1906. | 1907. | |
| January | $0. 30 | $0. 15–$0. 20 | $0. 2339–$0. 25 | $0. 62 –$0. 67 | $0. 63–$0. 66 |
| February | . 30 | . 15– . 20 | . 2414– . 25 | . 66 – . 75 | . 66– . 69 |
| March | . 40 | . 15– . 22 | . 25 – . 2761 | . 69 – . 80 | . 69– . 72 |
| April | $0. 40– . 50 | . 12– . 22 | . 2565– . 31 | . 72 – . 86 | . 72– . 75 |
| May | . 46– . 50 | . 12– . 22 | . 30 – . 33 | . 75 – . 92½ | . 75 |
| June | . 50– . 52 | . 12– . 20 | . 3404– . 35 | . 75 – . 97 | . 75– . 78 |
| July | . 45– . 57 | . 12– . 20 | . 3467– . 38 | . 78 – 1. 05 | . 78– . 83 |
| August | . 40– . 50 | . 16– . 20 | . 3525– . 43 | . 83 – 1. 08 | . 83– . 85 |
| September | . 30– . 44 | . 18– . 20 | . 3611– . 48 | . 85 – . 94½ | . 85 |
| October | . 30– . 46 | . 18– . 23 | . 4026– . 55 | . 79 – . 8713 | . 79 . 85 |
| November | . 22– . 35 | . 20– . 25 | . 448 – . 60 | . 74 – . 9214 | . 74– . 79 |
| December | . 18– . 33 | . 20– . 27 | . 615 – . 65 | . 6561 – . 80 | . 74 |
| Average | . 3589 | . 1788 | . 3906 | . 813 | . 777 |

The following table gives a statement of shipments of crude petroleum from stations on the line of the Louisiana Western Railroad Company and of the Kansas City Southern Railway in Louisiana during the year 1907, by months:

*Rail shipments of crude petroleum from Jennings, Mermentau, Egan, Lake Charles, and Caddo stations, Louisiana, during the year 1907, by months, in barrels.*

| Month. | Jennings. | Mermentau. | Egan. | Lake Charles. | Caddo. | Total. |
|---|---|---|---|---|---|---|
| January | 337,582 | 22,270 | 38,546 | 42,224 | 2,232 | 442,854 |
| February | 188,603 | 8,548 | 62,265 | 37,299 | 2,470 | 299,185 |
| March | 174,920 | 10,946 | 89,381 | 51,386 | 1,994 | 328,627 |
| April | 80,507 | 5,310 | 32,124 | 4,734 | 2,366 | 125,041 |
| May | 78,789 | 10,225 | 32,749 | 24,819 | 1,613 | 148,195 |
| June | 108,229 | 7,393 | 15,580 | 1,224 | 1,627 | 134,053 |
| July | 147,379 | 6,235 | 22,025 | 38,141 | 2,327 | 216,107 |
| August | 157,175 | 8,828 | 13,545 | 334 | 8,580 | 188,462 |
| September | 129,229 | 7,961 | 10,560 | 19,236 | 6,051 | 173,037 |
| October | 99,674 | 10,260 | 22,715 | 22,203 | 4,949 | 159,801 |
| November | 193,090 | 12,436 | 24,506 | 45,026 | 2,494 | 277,642 |
| December | 131,639 | 8,212 | 96,065 | 50,009 | 8,205 | [a] 297,260 |
| Total | 1,826,816 | 118,624 | 460,151 | 336,635 | 44,908 | [a] 2,790,264 |

[a] Includes a shipment of 973,000 pounds, or 3,130 barrels, from Anse-la-Butte in December.

NOTE.—These are the official figures, calculations being made on the basis of 310.8 pounds of crude petroleum to a barrel of 42 gallons.

## CALIFORNIA OIL FIELD.

With the development of the petroleum industry in California and the use of crude oil for fuel purposes the railroad and manufacturing industries have expanded to a marked degree, and have in turn created new and increased demands upon the oil-producing districts. The coal resources of the State are comparatively insignificant and do not enter into the industrial situation. All industries were particularly active in 1907, and the natural result was an increased production of petroleum for fuel purposes. And since much of the increase came from the Santa Maria district, the product of the refineries increased also. In the latter part of the year two good gushers were brought in in the Santa Maria district, and at the close one was also obtained at Carpinteria. A new deep stratum was found in the Whittier district. Another important feature of the year was the completion of the Standard Oil Company's new pipe line from the Midway district to Wade, on the Southern Pacific, from which point the oil is shipped in tank cars.

The total production for the State increased from 33,098,598 barrels in 1906 to 39,748,375 barrels in 1907, or about 20 per cent. Every large district shared in the increase except Kern River, where the decline was only slight. The Newhall, Whittier, and Summerland districts also declined.

Prices rose with increased demand, the average for the year being 37 cents per barrel, against 29 cents in 1906. The subsequent rise in price in 1908 is even more significant.

Several of the California oil regions have been described in detail by Messrs. George H. Eldridge, Ralph Arnold, and Robert Anderson in the following bulletins of the United States Geological Survey, and a bulletin descriptive of the Coalinga district is in process of publication; Bulletin 309, The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California; Bulletin 321, Geology and oil resources of the Summerland district, Santa Barbara County, Cal.; and Bulletin 322, Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal.

The average California oil is heavy, and contains much asphalt. It is low in volatile constituents, and these being largely composed of aromatic oils the crude oil is difficult to refine without yielding a product which burns with a smoky flame. This, however, has been accomplished by the aid of much skillful work, involving unusually great expense, and the credit for which is chiefly due to the chemists of the Standard Oil Company. The increase in the product from the Santa Maria oil district modifies this average character of California oil for the better, as the total percentage of volatile products is significantly increased.

A complete series of analyses of all the oils of California has been undertaken by Dr. Irving C. Allen, in the Technologic Branch of the United States Geological Survey, and is being pushed energetically, so that the fuel character especially will be well understood within a short time. This is by far the most complete and comprehensive analytical investigation of the California oils that has yet been attempted.

## DEVELOPMENT IN THE CALIFORNIA OIL FIELD IN 1907.

Owing to the increase in the value of California petroleum during the last two years, development work has been very rapid in all of the districts, and the production of many of the companies has been almost doubled within the year. The details given below are furnished by Mr. Ralph Arnold, in charge of the California petroleum investigations. This development work is largely within proven territory, but some prospect wells are being drilled outside of the proven districts. The most important prospect work now going on is in the vicinity of Peachtree, east of King City, Monterey County, where the Standard, the Union, and some other companies are prospecting in territory which has heretofore received no attention from oil men.

*Los Angeles district.*—New developments in the Los Angeles district extended northwestward from the main part of the Salt Lake district on La Brea Rancho to the vicinity of Sherman and southwest of that village. A number of very productive wells have been put down in this territory, and the indications are that a most important addition to the Los Angeles district will soon be in full operation.

*Newport district.*—A productive well has been brought in in the vicinity of Newport in Orange County which bids fair to open up an entirely new district. Little is known of the details of this new territory, as no work has been done there by the Survey geologists.

*Coalinga district.*—The developments in the Coalinga district have been largely within the proven territory. One new well of importance, namely, that of the T. C. Oil Company, north of the Eastside field, has proven the territory for at least 2 miles north of what was before known as productive ground. The development work is going on rapidly in this direction, and the extension of the field for several miles northwest of the present limits is within the bounds of probability.

*Santa Maria district.*—Extensions in the Santa Maria district have been in a direction east from the main Graciosa Ridge. Wells in the vicinity of Canada del Gato have proven the north flanks of Gato Ridge anticline to be productive. Wells in the vicinity of Sisquoc have also shown indications of productiveness. These developments will open up considerable additional territory for the Santa Maria district.

*Puente Hills district.*—Development work in the Puente Hills district has proven new territory in La Habra Canyon and also along the anticline of Coyote Hills, 4 miles south of the regular belt of the Puente Hills productive territory.

*Santa Clara Valley district.*—Development in the Santa Clara Valley fields has proven some new territory, especially in the vicinity of Sespe Canyon, where the Elk Oil Company has brought in some good wells.

*Sunset-Midway-McKittrick districts.*—Development work in these districts has gone on steadily with a resultant increase in the amount of proven territory. The trend of developments in the McKittrick district is northwesterly along the flanks of the mountains toward the Temblor ranch, indicating that the whole of the territory between the already proven field and the Temblor ranch wells is productive ground.

## PROPOSED LEGISLATION.

During the first session of the Sixtieth Congress an effort was made to revise the public-land laws in regard to the location of petroleum lands in California. On December 9, 1907, a bill to this effect was introduced in the House of Representatives by Hon. S. C. Smith, of California, and on January 20, 1908, the same bill was introduced in the United States Senate by Senator F. P. Flint, of California. Under this bill any citizen is allowed to locate 160 acres of land by the declaration of his belief, under oath, that the land is chiefly valuable for petroleum or asphalt. On filing said application the applicant must pay 25 cents per acre. At any time within three years the land may be patented after showing has been made that it contains petroleum which can be produced in commercial quantities and on the payment of $5 per acre. One citizen is allowed to patent 160 acres of land and no more. This bill passed the House of Representatives January 20, 1908, but was not acted upon by the Mining Committee of the Senate, to which it was referred, and it is in position to receive consideration by that body during the second session of the Sixtieth Congress next winter.

Efforts were also made to amend the Dingley tariff act so that no duty on petroleum, crude or refined, shall be collected at any port of the United States. Legislation to this effect was introduced in the House of Representatives, but failed to be reported upon by the Committee on Ways and Means, to which it was referred.

## PRODUCTION.

In the following table will be found the production and value of crude petroleum in California for the years 1906 and 1907, by counties:

*Production and value of crude petroleum in California in 1906 and 1907, by counties.*

| County. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity (barrels). | Value. | Price per barrel. | Quantity (barrels). | Value. | Price per barrel. |
| Fresno | 7,991,039 | $1,848,300 | $0.231 | 8,871,723 | $3,091,934 | $0.3485 |
| Kern | 14,520,854 | 3,342,760 | .230 | 15,652,156 | 4,301,102 | .275 |
| Los Angeles | 3,449,119 | 1,584,613 | .459 | 3,477,235 | 1,749,980 | .503 |
| Orange | 2,032,637 | 1,014,337 | .499 | 2,604,982 | 1,325,057 | .509 |
| Santa Barbara | 4,774,361 | 1,633,215 | .342 | 8,708,077 | 4,003,553 | .46 |
| Ventura | 299,124 | 119,275 | .399 | 357,094 | 197,537 | .553 |
| San Mateo | 31,464 | 10,930 | .347 | 77,108 | 30,793 | .399 |
| Santa Clara | | | | | | |
| San Luis Obispo | | | | | | |
| Total | 33,098,598 | 9,553,430 | .289 | 39,748,375 | 14,699,956 | .37 |

The following table shows the production of crude petroleum in California, by counties, from 1902 to 1907, inclusive:

*Production of crude petroleum in California, 1902–1907, by counties, in barrels.*

| Year. | Fresno. | Kern. | Los Angeles. | Orange. | Santa Barbara. | Ventura. | Santa Clara. | San Mateo. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1902 | 572,498 | 9,705,703 | 1,938,114 | 1,038,549 | 242,840 | 484,764 | ........ | 1,800 | 13,984,268 |
| 1903 | 2,138,058 | 18,077.900 | 2,087,627 | 1,413,782 | 306,066 | 348,295 | 5,607 | 5,137 | 24,382,472 |
| 1904 | 5,114,958 | 19,608,045 | 2,102.892 | 1,473,335 | 789,006 | 517,770 | 41,928 | 1,500 | 29,649,434 |
| 1905 | 10,967,015 | 14,487,967 | 3,469,433 | 1,429,688 | 2,684,837 | 337,970 | 50,563 | | 33,427,473 |
| 1906 | 7,991,039 | 14,520,864 | 3,449,119 | 2,032,637 | 4,774,361 | 299,124 | [a]31,464 | | 33,098.598 |
| 1907 | 8,871,723 | 15,652,156 | 3,477,235 | 2,604,982 | 8,708,077 | 357,094 | [a]77,108 | | 39,748,375 |

[a] Includes oil produced in San Luis Obispo County.

*Production of petroleum in California in 1906 and 1907, by districts, with increase or decrease, in barrels.*

| District. | 1906. | 1907. | Increase. | Decrease. |
|---|---|---|---|---|
| Los Angeles City | 2,586,779 | 2,659,088 | 72,309 | ........... |
| Salt Lake | | | | |
| Puente Hills | 862,340 | 818,147 | ........... | 44,193 |
| Newhall | | | | |
| Whittier | | | | |
| Total | 3,449,119 | 3,477,235 | 28,116 | ........... |
| Kern River | 13,580,334 | 13,006,136 | ........... | 574,198 |
| Sunset | 409,335 | 567,175 | 157,840 | ........... |
| Midway | ........... | 134,174 | 134,174 | ........... |
| McKittrick | 531,185 | 1,944,671 | 1,413,486 | ........... |
| Total | 14,520,854 | 15,652,156 | 1,131,302 | ........... |
| Santa Maria | 4,692,513 | 8,651,172 | 3,958,659 | ........... |
| Summerland | 81,848 | 56,905 | ........... | 24,943 |
| Total | 4,774,361 | 8.708,077 | 3,933,716 | ........... |
| Coalinga | 7,991,039 | 8,871,723 | 880,684 | ........... |
| Fullerton | 2,032,637 | 2,604,982 | 572,345 | ........... |
| Ventura | 299,124 | 357,094 | 57,970 | ........... |
| Santa Clara | 31,464 | 77,108 | 45,644 | ........... |
| San Luis Obispo | | | | |
| San Mateo | | | | |
| Total | 33,098,598 | 39,748,375 | 6,649,777 | ........... |

### WELL RECORD.

In the following table will be found the acreage and number of wells drilled in the different counties of California during the year 1907, with the number producing in each county at the beginning and the end of the year:

*Well record in California, 1907, by counties.*

| County. | Number of companies having wells active or idle or in process of drilling. | Acreage of oil land controlled. | Wells, Jan. 1, 1907. | | | Wells drilled in 1907. | | | | Wells abandoned in 1907. | Total wells Dec. 31, 1907. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Active. | Idle. | Total. | Gas. | Oil. | Dry. | Total. | | |
| Fresno | 83 | 24,025 | 274 | 9 | 283 | ...... | 45 | 1 | 46 | 3 | 325 |
| Kern | 127 | 44,596 | 901 | 224 | 1,125 | ...... | 135 | 3 | 138 | 15 | 1,245 |
| Los Angeles | [a] 96 | [a] 22,908 | 711 | 84 | 795 | ...... | 62 | 3 | 65 | 22 | 835 |
| Orange | 13 | 14,9[illegible]7 | 173 | ...... | 173 | ...... | 15 | ...... | 15 | ........ | 188 |
| San Luis Obispo | 24 | 14,299 | 5 | 6 | 11 | ...... | 4 | 2 | 6 | 5 | 10 |
| San Mateo | | 320 | | | | | | | | | |
| Santa Clara | | 6,009 | | | | | | | | | |
| Santa Barbara | 46 | 137,081 | 245 | 31 | 276 | 2 | 29 | 2 | 33 | 15 | 292 |
| Ventura | 20 | 98,344 | 167 | 86 | 253 | ...... | 6 | ...... | 6 | 2 | 257 |
| Total | 409 | 362,490 | 2,476 | 440 | 2,916 | 2 | 296 | 11 | 309 | 62 | 3,152 |

[a] Exclusive of city of Los Angeles, where wells are located on small lots.

## OTHER STATES.

### UTAH AND WYOMING.

### UTAH.

During the year 1907 petroleum was discovered by the Virgin River Oil and Development Company in a well near Virgin City, Washington County, Utah, the production being of sufficient quantity and quality to create excitement, and immediately there was a rush of prospectors to the field and drilling began, but up to the close of the year 1907 results have not been very encouraging, no other well in the field having reached the oil sand. Oil was struck on July 13 at a depth of 566 feet; the well was entirely within red shale overlying the oil sand. The well was drilled 700 feet in thirteen days with only 36 feet of casing in the hole. The oil contains both paraffin and asphalt. The product of this well, which has a capacity of about 20 barrels per day, has been used for fuel in the development of the field. At the close of 1907 more than 21 wells were drilling, and it is reported that all show a small production, ranging from one-fourth of a barrel to 2 barrels, of the same grade of oil; but with the exception of the first well drilled none are what would be called commercial producers.

A sample taken from a barrel of quite fresh oil and examined by the writer showed specific gravity 0.918 (or 22.5° Baumé); color, black; odor, of sulphuretted hydrogen. By distillation in an Engler bulb it gave 2.1 per cent of naphtha, distilling below 150° C.; 19.3 per cent of illuminating oil, which is easily refined; and left 78.4 c. c. of liquid residuum (specific gravity, 0.9475).

## WYOMING.

A comprehensive description of the more important Wyoming oils has been published in Professional Paper No. 56[a] by Mr. A. C. Veatch and associates, and readers are referred to it for detailed descriptions of this region.

*Bighorn County.*—Three oil wells, having an estimated capacity of 40 barrels per day, have been completed near the town of Bryan, Bighorn County, but as yet no crude oil has been shipped from this field, as there is no market for the product. The wells are 650 feet in depth. Three wells are now in process of drilling, and it is reported that 10 more will be started before the middle of 1908.

*Uinta County.*—At Spring Valley, Uinta County, there was a total of 17 productive oil wells at the close of 1907, and 2 in process of drilling. Only 6 of these wells were pumped in 1907. The first oil sand is found at a depth of 1,000 feet. During 1907 a refinery of 125-barrel capacity was put into operation by the Pittsburg-Salt Lake Oil Company, to which oil was delivered from wells in this field. The principal products of the refinery in 1907 were gasolene and water-white kerosene, which were disposed of in the local market. The crude oil has an average gravity of 43° Baumé, paraffin base, and is found in black, hard shale. Sixty-five per cent is illuminating oil and gasolene.

*Crook County.*—About 15 miles north of Moorcroft, Crook County, 7 wells, with an estimated capacity of 30 barrels per day of high-grade lubricating oil, have been completed, but there is no market for the product except the local market in the immediate neighborhood of the wells. Were it not for the excessive freight rates charged by the railroads this crude oil could be shipped to cities not far distant, where a ready market could be found for it. A quantity of petroleum from these wells is now stored in the field awaiting a market.

*Converse County.*—During the year 1907 some crude oil was produced from wells in Douglas district, Converse County, most of which was used in the making of stock dip, a smaller quantity being used for fuel in development work in the field. When the pipe line and refinery improvements now under way are completed the production of crude oil will be considerably increased.

*Natrona County.*—The wells of Salt Creek oil basin, Natrona County, were not operated in 1907, there being sufficient stock of crude on hand December 31, 1906, to supply the refinery in 1907.

*Fremont County.*—No crude petroleum was sold and shipped from this district in 1907. It is reported that a trial test made in locomotives of crude from the "Murphy" wells in this county proved that this oil could be used successfully for fuel purposes.

### PRODUCTION.

The total production of crude petroleum in Wyoming and Utah amounted to 9,339 barrels in 1907, valued at $21,883, an average price of $2.343 per barrel. The price ranged from $1.25 to $5 per barrel.

As there was but one producer in Utah in 1907, the production of this State has been included with that of Wyoming.

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[a] Veatch, A. C., Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil. Prof. Paper U. S. Geol. Survey, No 56, 1907.

In the following table is found the production of petroleum in Wyoming from 1894 to 1907, inclusive:

*Production of petroleum in Wyoming, 1894-1907.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| 1894 | 2,369 | 1901 | 5,400 |
| 1895 | 3,455 | 1902 | 6,253 |
| 1896 | 2,878 | 1903 | 8,960 |
| 1897 | 3,650 | 1904 | 11,542 |
| 1898 | 5,475 | 1905 | 8,454 |
| 1899 | 5,560 | 1906 | [a] 7,000 |
| 1900 | 5,450 | 1907 | [b] 9,339 |

## COLORADO.

The oil production of Colorado is obtained from the two pools already described in these reports, one in the neighborhood of Florence, the other known as the Boulder field district. In 1907 the product declined slightly in the older Florence field, and this was more than made up in the Boulder field, so that the total showed a net gain from 327,582 barrels in 1906 to 331,851 barrels in 1907, with a proportionate increase in value. During the year an additional plant was installed at the Florence refinery for making paraffin wax and began successful operation. The production in previous years is shown in the following tables.

In the following table is given the production of crude petroleum in the Florence and Boulder fields, by months, in 1906 and 1907:

*Production of crude petroleum in the Florence and Boulder fields in 1906 and 1907, by months, in barrels.*

| Month. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Florence. | Boulder. | Total. | Florence | Boulder. | Total. |
| January | 23,561 | 2,618 | 26,179 | 22,328 | 6,691 | 29,019 |
| February | 23,225 | 2,834 | 26,059 | 19,275 | 6,143 | 25,418 |
| March | 25,515 | 2,334 | 27,849 | 20,333 | 5,610 | 25,943 |
| April | 24,475 | 2,740 | 27,215 | 19,736 | 5,831 | 25,567 |
| May | 25,730 | 2,904 | 28,634 | 22,380 | 7,722 | 30,102 |
| June | 24,011 | 2,173 | 26,184 | 23,198 | 7,104 | 30,302 |
| July | 25,435 | 3,290 | 28,725 | 22,462 | 5,761 | 28,223 |
| August | 24,122 | 6,415 | 30,537 | 22,980 | 3,959 | 26,939 |
| September | 20,445 | 5,728 | 26,173 | 22,570 | 5,874 | 28,444 |
| October | 20,208 | 4,990 | 25,198 | 22.706 | 5,609 | 28,315 |
| November | 19,316 | 4,630 | 23,946 | 22,140 | 4,771 | 26,911 |
| December | 22,587 | 8,296 | 30,883 | 23,390 | 3,278 | 26,668 |
| Total | 278,630 | 48,952 | 327,582 | 263,498 | 68,353 | 331,851 |

In the following table will be found the production and value of crude petroleum from the Boulder and Florence fields in Colorado from 1902 to 1907, inclusive:

*Production and value of crude petroleum in Colorado, 1902-1907, by districts, in barrels.*

| Year. | Boulder. | | Florence. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 11,800 | .......... | 385,101 | .......... | 396,901 | $484,683 |
| 1903 | 36,722 | .......... | 447,203 | .......... | 483,925 | 431,723 |
| 1904 | 18,167 | $20,034 | 483,596 | $558,001 | 501,763 | 578,035 |
| 1905 | 10,502 | 11,502 | 365,736 | 326,104 | 376,238 | 337,606 |
| 1906 | 48,952 | 53,847 | 278,630 | 208,828 | 327,582 | 262,675 |
| 1907 | 68,353 | 75,188 | 263,498 | 197,625 | 331,851 | 272,813 |

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[a] Estimated.

[b] Includes the production of Utah.

## MISSOURI AND MICHIGAN.

The slight production noted in previous years continued in 1907, as shown in the following table:

*Production of petroleum in Missouri, 1901–1907.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| 1901 | [a]2,335 | 1905 | [b]3,100 |
| 1902 | [b]757 | 1906 | [b]3,500 |
| 1903 | [b]3,000 | 1907 | [b]4,000 |
| 1904 | [b]2,572 | | |

## ALASKA.

There were no developments in the petroleum industry in Alaska in 1907. Two of the wells which were drilled several years ago at Controller Bay, however, were pumped and furnished a local supply of petroleum for use in railway construction. There was some further prospecting with drills, but it does not seem to have yielded any very definite results.

So far as learned no work whatever has been done in the last two years on the Cook Inlet fields.

In the following table are given the shipments of petroleum products to Alaska from 1905 to 1907, inclusive:

*Shipments of petroleum products to Alaska from other parts of the United States, 1905–1907, in gallons.*

| Year. | Crude. | | Naphtha. | | Illuminating. | | Lubricating. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 2,715,386 | $91,068 | 713,496 | $109,921 | 627,391 | $113,921 | 83,319 | $31,660 |
| 1906 | 2,688,100 | 38,409 | 580,978 | 100,694 | 568,033 | 109,964 | 83,992 | 32,854 |
| 1907 | 9,104,300 | 143,506 | 636,881 | 119,345 | 510,145 | 99,342 | 100,145 | 37,929 |

## HAWAIIAN ISLANDS, PHILIPPINE ISLANDS, AND PORTO RICO.

In the following table are given the shipments of petroleum products to the Hawaiian Islands, Philippine Islands, and Porto Rico from 1905 to 1907, inclusive:

*Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico. 1905–1907, in gallons.*

| Year. | Crude. | | Naphtha. | | Illuminating. | | Lubricating. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| HAWAII. | | | | | | | | |
| 1905 | 31,904,340 | $1,112,939 | 320,703 | $39,069 | 892,094 | $142,313 | 195,850 | $61,605 |
| 1906 | 38,883,100 | 871,830 | 550,975 | 71,954 | 1,225,864 | 190,443 | 241,567 | 76,134 |
| 1907 | 38,916,400 | 581,905 | 484,435 | 73,405 | 1,441,637 | 230,968 | 355,451 | 104,930 |
| PHILIPPINES. | | | | | | | | |
| 1905 | | | 60,000 | 9,096 | 3,847,810 | 380,322 | 236,123 | 44,573 |
| 1906 | 7,360 | 442 | 40,450 | 6,482 | 4,412,398 | 398,706 | 195,006 | 39,887 |
| 1907 | | | 79,560 | 12,930 | 8,218,400 | 842,111 | 181,504 | 32,508 |
| PORTO RICO. | | | | | | | | |
| 1905 | | | 49,493 | 7,697 | 1,365,446 | 140,569 | 93,513 | 20,253 |
| 1906 | 16,585 | 1,224 | 79,841 | 17,766 | 1,315,589 | 151,013 | 196,732 | 41,777 |
| 1907 | | | 219,691 | 38,003 | 1,700,838 | 176,808 | 223,389 | 53,599 |

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[a] Includes the production of Michigan and Oklahoma Territory.
[b] Includes the production of Michigan.

## EXPORTS.

The following tables are the official statement by the Bureau of Statistics of the Department of Commerce and Labor of the quantity and value of petroleum and its products (mineral oils) exported from ports and districts in the United States for the years ending December 31, 1906 and 1907:

*Exports of mineral oils from the United States in 1906 and 1907, by kind and port, in gallons.*

| Port and kind. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| CRUDE. | | | | |
| Delaware | 25,911,771 | $1,473,863 | ........ | ........ |
| New York | 71,871 | 5,500 | 420,504 | $25,600 |
| Philadelphia | 62,636,172 | 3,812,319 | 75,518,259 | 4,798,585 |
| Galveston | 30,045,185 | 1,486,298 | 4,821,699 | 241,238 |
| Other districts | 29,380,316 | 953,246 | 45,546,087 | 1,268,292 |
| Total | 148,045,315 | 7,731,226 | 126,306,549 | 6,333,715 |
| NAPHTHA. | | | | |
| Baltimore | 1,000 | 200 | 1,505 | 303 |
| Boston and Charlestown | 5,220 | 875 | 18,816 | 3,305 |
| Delaware | 41,565 | 3,824 | ........ | ........ |
| New York | 12,512,596 | 1,235,841 | 16,300,755 | 1,870,151 |
| Philadelphia | 12,553,774 | 969,880 | 11,749,363 | 1,094,768 |
| Galveston | ........ | ........ | 50 | 12 |
| Other districts | 2,430,784 | 277,781 | 6,555,036 | 707,667 |
| Total | 27,544,939 | 2,488,401 | 34,625,525 | 3,676,206 |
| ILLUMINATING. | | | | |
| Baltimore | 1,422,416 | 114,485 | 4,026,217 | 264,843 |
| Boston and Charlestown | 338,603 | 42,018 | 302,286 | 37,779 |
| Delaware | 2,625 | 251 | ........ | ........ |
| New York | 499,427,210 | 34,301,950 | 535,945,536 | 38,903,722 |
| Philadelphia | 310,016,971 | 16,860,418 | 288,163,576 | 16,410,530 |
| Galveston | 16,519,394 | 993,751 | 2,872,830 | 163,975 |
| Other districts | 50,546,885 | 2,545,439 | 74,603,851 | 3,854,359 |
| Total | 878,274,104 | 54,858,312 | 905,924,296 | 59,635,208 |
| LUBRICATING AND PARAFFIN. | | | | |
| Baltimore | 4,958,839 | 610,492 | 4,649,512 | 657,746 |
| Boston and Charlestown | 176,077 | 31,895 | 409,262 | 76,484 |
| New York | 94,329,314 | 12,358,999 | 95,483,024 | 12,771,107 |
| Philadelphia | 44,001,460 | 4,345,237 | 44,325,811 | 4,607,271 |
| Galveston | 3,249,545 | 454,941 | 30,225 | 5,835 |
| Other districts | 4,553,287 | 888,058 | 7,131,021 | 1,091,910 |
| Total | 151,268,522 | 18,689,622 | 152,028,855 | 19,210,353 |
| RESIDUUM. | | | | |
| Boston and Charlestown | 535,000 | 26,750 | 464,500 | 14,510 |
| Delaware | 1,515,740 | 40,622 | ........ | ........ |
| New York | 13,428,198 | 421,510 | 2,564,869 | 95,997 |
| Philadelphia | 39,397,584 | 1,167,341 | 44,803,506 | 1,477,635 |
| Galveston | 8,415,971 | 253,744 | 1,473,585 | 44,208 |
| Other districts | 1,352,272 | 61,338 | 26,468,294 | 895,232 |
| Total | 64,644,765 | 1,971,305 | 75,774,754 | 2,527,582 |
| Grand total | 1,269,777,645 | 85,738,866 | 1,294,659,979 | 91,383,064 |

### RECAPITULATION BY KINDS, IN GALLONS.

| | | | | |
|---|---|---|---|---|
| Crude petroleum | 148,045,315 | $7,731,226 | 126,306,549 | $6,333,715 |
| Naphtha | 27,544,939 | 2,488,401 | 34,625,525 | 3,676,206 |
| Illuminating oil | 878,274,104 | 54,858,312 | 905,924,296 | 59,635,208 |
| Lubricating oil and paraffin | 151,268,522 | 18,689,622 | 152,028,855 | 19,210,353 |
| Residuum | 64,644,765 | 1,971,305 | 75,774,754 | 2,527,582 |
| Total | 1,269,777,645 | 85,738,866 | 1,294,659,979 | 91,383,064 |

*Exports of mineral oils from the United States in 1906 and 1907, by kind and port, in gallons*—Continued.

RECAPITULATION BY PORTS, IN GALLONS.

| | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Baltimore | 6,382,255 | $725,177 | 8,677,234 | $922,892 |
| Boston and Charlestown | 1,054,900 | 101,538 | 1,194,864 | 132,078 |
| Delaware | 27,471,701 | 1,518,560 | .......... | .......... |
| New York | 619,769,189 | 48,323,800 | 650,714,688 | 53,666,577 |
| Philadelphia | 468,605,961 | 27,155,195 | 464,560,515 | 28,388,789 |
| Galveston | 58,230,095 | 3,188,734 | 9,198,389 | 455,268 |
| Other districts | 88,268,544 | 4,725,862 | 160,314,289 | 7,817,460 |
| Grand total | 1,269,777,645 | 85,738,866 | 1,294,659,979 | 91,383,064 |

*Exports of mineral oils from the United States in 1907, by months, in gallons.*

| Month. | Quantity. | Value. |
|---|---|---|
| January | 87,981,293 | $6,015,832 |
| February | 102,828,152 | 6,882,255 |
| March | 93,439,670 | 6,832,168 |
| April | 108,265,855 | 7,728,139 |
| May | 93,827,835 | 6,189,142 |
| June | 106,397,256 | 7,793,560 |
| July | 120,160,435 | 8,835,296 |
| August | 128,737,365 | 9,373,169 |
| September | 108,856,386 | 7,586,557 |
| October | 119,837,732 | 8,458,379 |
| November | 115,222,160 | 8,093,983 |
| December | 109,105,840 | 7,594,584 |
| Total | 1,294,659,979 | 91,383,064 |

The following table exhibits the total production of crude petroleum from 1901 to 1907, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value. The exports represent approximately 45 per cent of the total refined product that was obtained from the crude petroleum in the United States during that period:

*Quantity of crude petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1901 to 1907, inclusive, in gallons.*

| Year. | Production. | | Exports. | | | |
|---|---|---|---|---|---|---|
| | | | | | Mineral, refined or manufactured. | |
| | Barrels of 42 gallons. | Gallons. | Mineral, crude (including all natural oils, without regard to gravity). | | Naphtha, benzine, gasoline, etc. | |
| 1901 | 69,389,194 | 2,914,346,148 | 127,008,002 | $6,037,544 | 21,684,734 | $1,741,547 |
| 1902 | 88,766,916 | 3,728,210,472 | 145,233,723 | 6,331,011 | 19,682,637 | 1,392,771 |
| 1903 | 100,461,337 | 4,219,376,154 | 126,511,687 | 6,782,136 | 12,973,153 | 1,518,541 |
| 1904 | 117,080,960 | 4,917,400,320 | 111,176,476 | 6,350,682 | 24,989,422 | 2,321,714 |
| 1905 | 134,717,580 | 5,658,138,360 | 126,185,187 | 6,085,592 | 28,419,930 | 2,214,609 |
| 1906 | 126,493,936 | 5,312,745,312 | 148,045,315 | 7,731,226 | 27,544,939 | 2,488,401 |
| 1907 | 166,095,335 | 6,976,004,070 | 126,306,549 | 6,333,715 | 34,625,525 | 3,676,206 |

*Quantity of crude petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1901 to 1907, inclusive, in gallons*—Continued.

| Year. | Exports. | | | | Exports. | | | |
|---|---|---|---|---|---|---|---|---|
| | Mineral, refined or manufactured. | | | | Residuum (tar, pitch, and all other, from which the light bodies have been distilled). | | Total exports. | |
| | Illuminating. | | Lubricating (heavy paraffin, etc.). | | | | | |
| 1901... | 827,479,493 | $53,490,713 | 75,305,938 | $10,260,125 | 27,596,352 | $1,254,983 | 1,079,074,519 | $72,784,912 |
| 1902... | 778,800,978 | 49,079,055 | 82,200,503 | 10,872,154 | 38,315,760 | 922,152 | 1,064,233,601 | 68,597,143 |
| 1903... | 691,837,234 | 51,355,668 | 95,621,941 | 12,690,065 | 9,753,240 | 282,129 | 936,697,255 | 72,628,539 |
| 1904... | 761,358,155 | 58,384,273 | 89,688,123 | 12,393,382 | 34,904,100 | 1,174,156 | 1,022,116,276 | 80,624,207 |
| 1905... | 881,450,388 | 54,900,649 | 113,730,205 | 14,312,383 | 70,727,877 | 2,127,696 | 1,220,513,587 | 79,640,929 |
| 1906... | 878,274,104 | 54,858,312 | 151,208,522 | 18,689,622 | 64,644,765 | 1,971,305 | 1,269,777,645 | 85,738,866 |
| 1907... | 905,924,296 | 59,635,208 | 152,028,855 | 19,210,353 | 75,774,754 | 2,527,582 | 1,294,659,979 | 91,383,064 |

Exports of domestic crude petroleum from Pacific ports during the calendar years 1906 and 1907 were as follows:

*Exports of crude petroleum from Pacific ports in 1906 and 1907, in gallons.*

| Customs districts. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| From— | | | | |
| Puget Sound | 1,929,033 | $50,492 | 3,264,031 | $58,083 |
| San Diego | 2,812 | 120 | 1,700 | 135 |
| San Francisco | 1,070,420 | 15,548 | 9,448,246 | 180,583 |
| Willamette | 800 | 15 | 443,975 | 17,759 |
| To Panama | 2,253,963 | 36,723 | 4,088,800 | 63,465 |

Upon examination of the foregoing tables it will be observed that both the total quantity and the total value of exports of mineral oils increased in 1907 as compared with 1906. The total quantity exported in 1907 amounted to 1,294,659,979 gallons, as against 1,269,777,645 gallons in 1906, an increase of 24,882,334 gallons, or about 2 per cent. The total value of mineral oils exported in 1907 was $91,383,064, as compared with $85,738,866 in 1906, an increase of $5,644,198, or 6.58 per cent. It will also be noted that with the exception of crude oil all the products show increases in 1907 as compared with 1906. Referring to the table of exports by months, it will be seen that 128,737,365 gallons of oil were exported in August, which is the largest quantity on record. The average monthly exports for the year were 107,888,332 gallons. It is the third year in succession that the shipments abroad exceeded 1,220,000,000 gallons, or 4,016,915 metric tons. On the whole the exports were very satisfactory, and the returns the greatest reported.

## IMPORTS.

The imports of mineral crude oil to the United States in 1907 amounted to 1,392,555 gallons, valued at $91,547, and of refined petroleum to 3,556,250 gallons, valued at $194,705. There were also imported in 1907 into the United States 1,451,231 pounds of mineral wax (ozokerite), valued at $149,507.

## FOREIGN MARKETS.

In the following table is given a statement showing the foreign markets for our oil in the four fiscal years ending June 30, 1907:

*Exports of petroleum in its various forms from the United States for the fiscal years 1904–1907, by countries and kinds, in gallons.*

| Country and kind. | Year ending June 30— | | | |
|---|---|---|---|---|
| | 1904. | 1905. | 1906. | 1907. |
| CRUDE. | | | | |
| Europe: | | | | |
| France | 66,212,481 | 47,015,325 | 55,103,511 | 47,777,692 |
| Germany | 3,990,063 | 5,669,934 | 6,543,989 | 4,936,082 |
| Netherlands | 1,266,406 | 774,085 | .......... | .......... |
| Spain | 8,066,482 | 11,822,756 | 13,490,077 | 8,603,703 |
| United Kingdom | 12,021,692 | 14,075,577 | 19,131,352 | 12,660,797 |
| Other Europe | 100 | 529 | 1,250 | 897,520 |
| Total | 91,557,224 | 79,358,206 | 94,270,179 | 74,875,794 |
| North America: | | | | |
| Mexico | 10,938,441 | 14,036,517 | 14,366,495 | 19,992,434 |
| Cuba | 6,212,648 | 7,440,234 | 6,266,626 | 5,385,898 |
| Dominion of Canada | 5,862,148 | 22,220,665 | 23,882,943 | 22,571,811 |
| Other North America | 3,580 | 3,073 | 45,192 | 5,305,767 |
| Total | 23,016,790 | 43,700,489 | 44,561,256 | 53,255,910 |
| South America | .......... | 315 | 850,180 | 23,200 |
| All other countries | 2,906 | .......... | 7,000 | 20,833 |
| Total crude | 114,576,920 | 123,059,010 | 139,688,615 | 128,175,737 |
| REFINED. | | | | |
| *Naphtha.* | | | | |
| Europe: | | | | |
| France | 7,147,327 | 8,980,020 | 8,417,101 | 5,623,747 |
| Germany | .......... | 3,258,042 | 3,782,176 | 492,865 |
| Sweden | 284,302 | 268,354 | 259,648 | 336,045 |
| United Kingdom | 5,942,545 | 11,806,289 | 12,888,828 | 7,222,433 |
| Other Europe | 6,822 | 2,393,251 | 1,884,941 | 3,016,619 |
| Total | 13,380,996 | 26,705,956 | 27,232,694 | 16,691,709 |
| North America | 2,198,312 | 1,645,855 | 1,980,814 | 4,770,891 |
| West Indies | 34,601 | 32,042 | 80,338 | 131,825 |
| South America | 298,769 | 502,955 | 1,095,399 | 1,934,264 |
| Asia and Oceania | 794,264 | 1,572,965 | 1,664,071 | 2,214,135 |
| Africa | 203,179 | 356,882 | 703,278 | 614,290 |
| Total | 3,529,125 | 4,110,699 | 5,524,000 | 9,665,345 |
| Total naphtha | 16,910,121 | 30,816,655 | 32,756,694 | 26,357,054 |
| *Illuminating.* | | | | |
| Europe: | | | | |
| Belgium | 38,569,610 | 39,526,415 | 43,478,987 | 47,942,197 |
| Denmark | 22,162,981 | 15,550,986 | 18,120,251 | 16,123,410 |
| France | 3,843,527 | 9,875,589 | 22,739,414 | 32,632,548 |
| Germany | 113,069,001 | 126,577,304 | 110,336,514 | 120,183,398 |
| Italy | 12,736,187 | 23,048,026 | 28,979,309 | 22,627,583 |
| Netherlands | 111,328,359 | 110,037,453 | 123,208,276 | 113,779,776 |
| Sweden and Norway | 28,588,783 | 25,447,181 | 25,626,562 | 29,799,154 |
| United Kingdom | 165,248,727 | 174,057,928 | 190,383,239 | 182,328,955 |
| Portugal | 1,466,082 | 4,482,064 | 6,021,243 | 5,265,000 |
| Other Europe | 1,417,570 | 1,336,875 | 3,569,867 | 1,395,847 |
| Total | 498,430,827 | 529,939,821 | 572,463,662 | 572,077,868 |
| North America: | | | | |
| British North America | 20,085,691 | 13,767,128 | 11,263,304 | 10,088,253 |
| Central America | 1,331,845 | 1,462,787 | 2,014,071 | 2,014,242 |
| Mexico | 409,266 | 461,266 | 2,095,939 | 2,495,070 |
| West Indies— | | | | |
| British | 2,488,025 | 2,538,784 | 2,679,322 | 2,878,322 |
| Other | 2,912,099 | 3,728,017 | 2,901,690 | 3,264,340 |
| Other North America | 683,418 | 709,500 | 573,702 | 512,331 |
| Total | 27,910,344 | 22,667,482 | 21,528,028 | 21,252,558 |

*Exports of petroleum in its various forms from the United States, etc.*—Continued.

| Country and kind. | Year ending June 30— | | | |
|---|---|---|---|---|
| | 1904. | 1905. | 1906. | 1907. |
| REFINED—continued. | | | | |
| *Illuminating*—Continued. | | | | |
| South America: | | | | |
| Argentina | 12,216,938 | 15,818,832 | 14,430,159 | 14,900,929 |
| Brazil | 19,403,726 | 21,389,827 | 24,198,146 | 24,528,640 |
| Chile | 5,756,672 | 5,945,330 | 7,263,136 | 5,842,470 |
| Uruguay | 3,185,700 | 2,918,600 | 4,286,600 | 4,875,966 |
| Venezuela | 1,263,622 | 1,259,776 | 1,236,512 | 1,422,441 |
| Other South America | 3,772,257 | 3,391,885 | 3,520,193 | 3,510,906 |
| Total | 45,598,915 | 50,724,250 | 54,934,746 | 55,081,352 |
| Asia: | | | | |
| Chinese Empire | 40,614,179 | 89,368,014 | 54,376,377 | 77,913,487 |
| Hongkong | 22,308,570 | 18,660,090 | 5,561,590 | 12,048,815 |
| East Indies— | | | | |
| British | 9,667,103 | 24,853,070 | 38,204,743 | 37,837,841 |
| Dutch | 10,924,890 | 9,798,770 | 12,039,360 | 13,475,350 |
| Other East Indies | 3,872,450 | 1,242,000 | | 2,441,190 |
| Japan | 46,007,530 | 26,824,694 | 42,787,890 | 43,810,870 |
| Other Asia | 918,574 | 4,194,710 | 11,923,490 | 8,775,675 |
| Total | 134,313,296 | 174,941,348 | 164,893,450 | 196,303,228 |
| Oceania: | | | | |
| British Australasia | 18,212,764 | 21,633,821 | 20,618,140 | 21,621,640 |
| Philippine Islands | 3,294,020 | 7,358,810 | 1,641,178 | 6,141,490 |
| Other Oceania | 11,056 | 4,770 | 1,370 | 4,410 |
| Total | 21,517,840 | 28,997,401 | 22,260,688 | 27,767,540 |
| British Africa | 10,609,429 | 11,621,470 | 13,477,323 | 9,976,024 |
| Other Africa | 3,186,435 | 3,990,181 | 14,803,313 | 12,070,862 |
| Total | | | | 22,046,886 |
| Total illuminating | 741,567,086 | 822,881,953 | 864,361,210 | 894,529,432 |
| *Lubricating.* | | | | |
| Europe: | | | | |
| Belgium | 4,473,379 | 6,212,754 | 12,719,017 | 10,582,303 |
| France | 6,793,879 | 8,755,856 | 19,007,626 | 15,241,696 |
| Germany | 11,421,404 | 12,385,112 | 19,229,818 | 19,591,795 |
| Italy | 2,961,857 | 3,528,671 | 4,974,497 | 6,139,766 |
| Netherlands | 5,424,718 | 6,569,410 | 9,485,260 | 8,808,058 |
| United Kingdom | 33,890,901 | 35,571,115 | 46,245,278 | 42,141,248 |
| Other Europe | 2,864,739 | 3,514,778 | 5,736,974 | 5,648,556 |
| Total | 67,830,877 | 76,537,696 | 117,398,470 | 108,153,422 |
| North America | 2,709,577 | 2,603,403 | 3,244,991 | 4,344,831 |
| West Indies | 830,913 | 786,106 | 941,191 | 1,753,262 |
| South America | 3,470,324 | 3,621,853 | 4,840,251 | 5,402,478 |
| Asia and Oceania | 11,864,610 | 11,798,775 | 16,622,725 | 14,340,665 |
| Africa | 2,103,829 | 2,009,363 | 3,063,074 | 2,145,568 |
| Total | 20,979,253 | 20,819,500 | 28,712,232 | 27,986,804 |
| Total lubricating | 88,810,130 | 97,357,196 | 146,110,702 | 136,140,226 |
| *Residuum (barrels).* | | | | |
| Europe | 511,779 | 1,101,804 | 1,688,741 | 63,650,768 |
| North America | 24,131 | 59,768 | 95,451 | 1,323,710 |
| All other countries | 1,245 | 3,889 | 2,280 | 253,531 |
| Total residuum | 537,155 | 1,165,461 | 1,786,472 | 65,228,009 |

## PRICES.

In the following tables the prices per gallon of refined oils of 70° Abel test are given:

*Weekly prices of refined petroleum in the United States in 1907, in bulk and cases at New York and in barrels at Philadelphia, in cents per gallon.*

| Week ending— | Refined oil. | | | Week ending— | Refined oil. | | |
|---|---|---|---|---|---|---|---|
| | New York. | | Philadelphia. | | New York. | | Philadelphia. |
| | Bulk. | Cases. | Barrels. | | Bulk. | Cases. | Barrels. |
| January 5 | 4.50 | 10.25 | 7.75 | July 6 | 5.00 | 10.90 | 8.45 |
| January 12 | 4.50 | 10.25 | 7.75 | July 13 | 5.00 | 10.90 | 8.45 |
| January 19 | 4.50 | 10.25 | 7.75 | July 20 | 5.00 | 10.90 | 8.45 |
| January 26 | 4.50 | 10.25 | 7.75 | July 27 | 5.00 | 10 90 | 8.45 |
| February 2 | 4.50 | 10.25 | 7.75 | August 3 | 5.00 | 10.90 | 8.45 |
| February 9 | 4.50 | 10.25 | 7.75 | August 10 | 5.00 | 10.90 | 8.45 |
| February 16 | 4.50 | 10.25 | 7.75 | August 17 | 5.00 | 10.90 | 8.45 |
| February 23 | 4.50 | 10.25 | 7.75 | August 24 | 5.00 | 10.90 | 8.45 |
| March 2 | 4.65 | 10.30 | 7.80 | August 31 | 5.00 | 10.90 | 8.45 |
| March 9 | 4.65 | 10.30 | 7.50 | September 7 | 5.00 | 10.90 | 8.45 |
| March 16 | 4.70 | 10.50 | 7.95 | September 14 | 5.00 | 10.90 | 8.45 |
| March 23 | 4.70 | 10.65 | 8.20 | September 21 | 5.00 | 10.90 | 8.45 |
| March 30 | 4.70 | 10.65 | 8.20 | September 28 | 5.00 | 10.90 | 8.45 |
| April 6 | 4.70 | 10.65 | 8.20 | October 5 | 5.00 | 10.90 | 8.45 |
| April 13 | 4.70 | 10.65 | 8.20 | October 12 | 5.00 | 10.90 | 8.45 |
| April 20 | 4.70 | 10.65 | 8.20 | October 19 | 5.00 | 10.90 | 8.45 |
| April 27 | 4.70 | 10.65 | 8.20 | October 26 | 5.00 | 10.90 | 8.75 |
| May 4 | 4.70 | 10.65 | 8.20 | November 2 | 5.00 | 10.90 | 8.75 |
| May 11 | 4.70 | 10.65 | 8.25 | November 9 | 5.00 | 10.90 | 8.75 |
| May 18 | 4.70 | 10.65 | 8.25 | November 16 | 5.00 | 10.90 | 8.75 |
| May 25 | 4.70 | 10.65 | 8.25 | November 23 | 5.00 | 10.90 | 8.75 |
| June 1 | 4.70 | 10.75 | 8.35 | November 30 | 5.00 | 10.90 | 8.75 |
| June 8 | 4.70 | 10.90 | 8.45 | December 7 | 5.00 | 10.90 | 8.75 |
| June 15 | 4.95 | 10.90 | 8.45 | December 14 | 5.00 | 10.90 | 8.75 |
| June 22 | 4.95 | 10.90 | 8.45 | December 21 | 5.00 | 10.90 | 8.75 |
| June 29 | 4.95 | 10.90 | 8.45 | December 28 | 5.00 | 10.90 | 8.75 |

*Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1904-1907.*

| Month. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Crude. | Refined, illuminating. | Crude. | Refined, illuminating. | Crude. | Refined, illuminating. | Crude. | Refined, illuminating. |
| January | 6.4 | 8.1 | 5.3 | 6.6 | 5.4 | 6.2 | 5.3 | 6.3 |
| February | 6.1 | 8.7 | 5.4 | 6.2 | 5.3 | 6.4 | 4.9 | 6.1 |
| March | 5.9 | 8.3 | 5.3 | 6.8 | 5.3 | 6.5 | 4.8 | 6.8 |
| April | 6.3 | 7.5 | 4.5 | 7.0 | 5.2 | 6.2 | 5.3 | 6.8 |
| May | 5.7 | 7.8 | 4.6 | 5.9 | 5.1 | 6.3 | 4.1 | 6.1 |
| June | 5.8 | 7.8 | 4.9 | 5.9 | 5.2 | 6.8 | 5.8 | 6.8 |
| July | 5.9 | 7.1 | 4.8 | 5.9 | 5.1 | 6.3 | 5.6 | 6.8 |
| August | 5.4 | 7.5 | 4.1 | 6.1 | 5.3 | 6.2 | 5.5 | 6.8 |
| September | 5.0 | 7.9 | 4.7 | 5.8 | 4.9 | 6.0 | 4.8 | 6.6 |
| October | 5.6 | 7.7 | 4.8 | 6.2 | 5.2 | 6.3 | 4.9 | 6.6 |
| November | 5.2 | 7.1 | 4.5 | 6.5 | 5.2 | 5.9 | 4.9 | 6.6 |
| December | 5.8 | 6.9 | 5.1 | 6.4 | 5.3 | 6.1 | 3.7 | 6.6 |

*Wholesale prices of refined petroleum at New York at the first of each month, 1903-1907.*

| Month. | 1903. | | | 1904. | | | 1905. | | | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date. | Cents per gallon. | | Date. | Cents per gallon. | | Date. | Cents per gallon. | | Date. | Cents per gallon. | | Date. | Cents per gallon. | |
| | | In barrels. | In cases. | | In barrels. | In cases. | | In barrels. | In cases. | | In barrels. | In cases. | | In barrels. | In cases. |
| January | 7 | 8.30 | 10.60 | 6 | 9.10 | 11.80 | 4 | 7.65 | 10.35 | 3 | 7.60 | 10.30 | 5 | 7.50 | 10.00 |
| February | 4 | 8.20 | 10.50 | 3 | 9.10 | 11.80 | 1 | 7.25 | 9.95 | 7 | 7.60 | 10.30 | 2 | 7.75 | 10.25 |
| March | 4 | 8.20 | 10.50 | 2 | 8.75 | 11.40 | 1 | 7.25 | 9.95 | 7 | 7.60 | 10.30 | 2 | 7.75 | 10.25 |
| April | 1 | 8.35 | 10.50 | 6 | 8.50 | 11.20 | 5 | 7.15 | 9.85 | 4 | 7.60 | 10.30 | 6 | 8.20 | 10.65 |
| May | 6 | 8.35 | 10.50 | 4 | 8.15 | 10.85 | 3 | 6.95 | 9.65 | 2 | 7.60 | 10.30 | 4 | 8.20 | 10.65 |
| June | 3 | 8.55 | 10.50 | 1 | 8.15 | 10.85 | 7 | 6.90 | 9.60 | 6 | 7.80 | 10.30 | 1 | 8.20 | 10.65 |
| July | 1 | 8.55 | 10.50 | 6 | 7.95 | 10.65 | 5 | 6.90 | 9.60 | 6 | 7.80 | 10.30 | 6 | 8.45 | 10.90 |
| August | 5 | 8.55 | 10.50 | 3 | 7.70 | 10.40 | 2 | 6.90 | 9.60 | 2 | 7.80 | 10.30 | 3 | 8.45 | 10.90 |
| September | 3 | 8.55 | 10.50 | 7 | 7.85 | 10.55 | 6 | 6.90 | 9.60 | 7 | 7.50 | 10.00 | 7 | 8.45 | 10.90 |
| October | 7 | 8.80 | 11.50 | 5 | 7.95 | 10.65 | 4 | 7.60 | 10.30 | 6 | 7.50 | 10.00 | 5 | 8.45 | 10.90 |
| November | 4 | 9.20 | 11.90 | 2 | 7.95 | 10.65 | 1 | 7.70 | 10.40 | 3 | 7.50 | 10.00 | 2 | 8.75 | 10.90 |
| December | 2 | 9.50 | 12.20 | 7 | 7.95 | 10.65 | 6 | 7.00 | 10.30 | 1 | 7.50 | 10.00 | 7 | 8.75 | 10.90 |

## ANALYSES OF PETROLEUM FROM VARIOUS PARTS OF THE UNITED STATES.

In order to furnish a ready means of comparison of the various crude petroleums in the United States, the following tables have been compiled from all accessible publications, by Mr. J. P. Dunlop, of the United States Geological Survey.

In collecting these recorded analyses the following publications have been consulted:

Publications of the United States Geological Survey.

The State geological survey reports and bulletins of New York, Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Indiana, Illinois, Kansas, Louisiana, Texas, Colorado, Wyoming, and California.

The mineral industries volumes of the Tenth and Eleventh censuses.

Transactions of the American Institute of Mining Engineers.

American Journal of Arts and Sciences from 1850 to 1907.

Journal of the American Chemical Society.

American Chemical Journal, 1878 to 1907.

Journal of the Franklin Institute, 1840 to 1907.

Journal of the Chemical Society, 1859 to 1907.

Journal of the Society of Chemical Industry.

Philosophical Magazine.

The Chemical News.

The degrees of accuracy in the work and the methods of expressing the results differ greatly. In arranging the analyses effort has been made to show the variation in specific gravity, in percentage of sulphur, and in distillation products. Other analytical data are given under "remarks."

On the whole the tables are very incomplete, and show clearly the necessity for much additional work and especially for uniformity in the methods employed. The analyses cited show very full work in some fields and almost nothing in others. Information is lacking as to even the exact locality from which many of the samples came and the conditions under which any particular specimen was obtained. Usually there is no statement as to the care used in avoiding evaporation from the sample. The analytical methods vary to such an extent that as much as 30 per cent difference in the amount of naphtha will be shown in two samples from the same region, and thus far greater difference will be shown between two samples from the same pool than in the oils from widely separated districts. Yet there are no explanatory statements to make these differences intelligible. There is no more conclusive argument possible for the necessity of the general review of the analytical characteristics of all American oils which is now in progress, as is shown below.

The various petroleums of the country are now being collected and examined by the United States Geological Survey under such uniform conditions as will give a somewhat more rational table for purposes of comparison. The Survey will probably be able to publish this complete table in the report for 1908. The results already available have been included in this report.

*Analyses of petroleum from*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | ALASKA. | | | | | | | |
| 1 | | Katalla Bay | | | 0.828 | 39.5 | | | |
| 2 | | Katalla | | | .7958 | 45.9 | | | |
| 3 | | Cold Bay | Seepage | | .9547 | 16.6 | Dark green | | 225° C. |
| 4 | | Oil Bay | do | | .9557 | 16.5 | do | | 230° C. |
| | | COLORADO. | | | | | | | |
| 5 | | Boulder County | McKenzie | | .8304 | 38.6 | | 0° F. | |
| 6 | | Fremont County, Florence. | | | .8696 | 31.0 | Dark green | | |
| | | ILLINOIS. | | | | | | | |
| | | Clark County: | | | | | | | |
| 7 | | Johnson Township | Weaver lease, sec. 23. | | .887 | 27.8 | Olive green | 60° C. | 88° C. |
| 8 | | Parker Township | Briscoe lease, sec. 29. | | .873 | 30.4 | do | 38° C. | |
| 9 | | Crawford County, Oblong Township. | Birch lease | | .870 | 30.9 | do | 43° C. | 60° C. |
| 10 | | Randolph County, Sparta. | | | .842 | 36.3 | | 18° C. | |
| 11 | | Montgomery County, Litchfield. | | | .9236 | 21.6 | | | 110° C. |
| 12 | | Lawrence County, Bridgeport. | Snowden Bros. & Co | | .8309 | 38.5 | | | |
| | | Clark County, Parker Township, Oilfield pool: | | | | | | | |
| 13 | 23 | S. Spellbring farm, sec. 7; Ohio Oil Co. | 7 | 330 | .846 | 31.5 | Light green | | 63° C. |
| 14 | 24 | M. K. Young farm, sec. 18; Ohio Oil Co. | 27 | 330 | .846 | 35.5 | do | | 55° C. |
| 15 | 25 | G. H. Jeffries farm, sec. 20; Ohio Oil Co. | 21 | 325 | .853 | 34.1 | do | | 55° C. |
| | | Clark County, Parker Township pool: | | | | | | | |
| 16 | 26 | J. Turner lease, sec. 33; Ohio Oil Co. | 2, 4, 5, 6, 7, 10 | 300 | .879 | 29.3 | Medium green | | 65° C. |
| 17 | 29 | Do | 12 | 300 | .879 | 29.3 | Brown | | 65° C. |
| 18 | 27 | Kelly farm, sec. 33, Treat & Crawford. | 1, 2, 3, 4 | 300 | .865 | 31.9 | Light green | | 75° C. |
| 19 | 28 | N. J. Linn farm, Mars Oil and Gas Co. | 1–9 | 280–320 | .858 | 33.4 | do | | 65° C. |
| | | Cumberland County, Union Township: | | | | | | | |
| 20 | 16 | Queen farm, sec. 13; Campbell, McElroy & Bell. | 5, 8, 9, 10, 11, 13, 21. | 400 | .839 | 36.9 | do | | 60° C. |
| 21 | 17 | Do | 1, 2, 3, 4, 17, 18, 19. | 400 | .841 | 36.5 | do | | 60° C. |

1. Bull U. S. Geol. Survey No. 225, Penniman and Browne, analysts.
2. Mineral Resources U. S. for 1902, p. 583.
3, 4. Bull. U. S. Geol. Survey No. 250, Penniman and Browne, analysts.
5. Mineral Resources U. S. for 1901, p. 560 Prof. R. G. Hoffman, Dr. Frederick Salathe.

*various parts of the United States.*

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 21.0 | 0.7573 | 51.0 | 0.8204 | 28.0 | Tr. | ...... | Residuum paraffin base. | 1 |
| 38.5 | ...... | 31.0 | ...... | 30.5 | ...... | ...... | Residuum all over 285° C.; cold test—did not chill at 3° F. | 2 |
| ...... | ...... | 13.3 | .8772 | 86.7 | 0.116 | ...... | 86.7 p. ct. residuum includes 8.1 p. ct. coke and loss and products distilled under 120 mm. pressure up to 350° C., and also products by destructive distillation. | 3 |
| ...... | ...... | 13.2 | .8777 | 86.8 | .098 | ...... | 86.8 p. ct. residuum includes 5.6 p. ct. coke and loss and products distilled under 120 mm. pressure up to 350° C., and also products by destructive distillation. | 4 |
| 16.0 | .7368 | 40.0 | .8000 | 44.0 | ...... | ...... | Burning oil, 150° F. fire test. | 5 |
| ...... | ...... | 35-40 | ...... | ...... | ...... | ...... | Percentage of solid paraffin, 10.4; fixed carbon, 1.6; soluble bitumen as removed by $H_2SO_4$, 19; character of residuum soft; loss, 200° C. (7 hours), 2.4 p. ct. | 6 |
| 4.4 | .745 | 33.2 | .8120 | 62.4 | .13 | ...... | Sp. gr. of lubricating oil, 0.863; coke and loss, 12.4 p. ct. | 7 |
| 8.6 | .741 | 34.8 | .8138 | 56.6 | .73 | ...... | Sp. gr. of lubricating oil, 0.853; coke and loss, 8.6 p. ct. | 8 |
| 3.5 | .749 | 36.8 | .8060 | 59.7 | .10 | ...... | Sp. gr. of lubricating oil, 0.849; coke and loss, 9.5 p. ct. | 9 |
| 14.0 | .729 | 37.0 | .7972 | 49.0 | ...... | ...... | Sp. gr. of lubricating oil, 0.850; coke and loss, 7 p. ct.; sample had stood some time; burning point, 22° C. | 10 |
| 1.3 | (a) | 16.9 | .852 | 81.8 | ...... | ...... | Sp. gr. of lubricating oil, 0.863; coke and loss, 10.7 p. ct.; sample out of ground some months.<br>a Specimen too small to test. | 11 |
| 16.79 | ...... | 31.23 | ...... | 51.98 | ...... | ...... | (From statistical report to U. S. Geological Survey in 1907.) | 12 |
| 14.0 | .7745 | 31.0 | .8145 | ...... | .48 | ...... | ...... | 13 |
| 10.5 | .7357 | 34.0 | .8184 | ...... | .35 | .. | ...... | 14 |
| 15.5 | .7323 | 30.5 | .8173 | ...... | .47 | ...... | ...... | 15 |
| 8.5 | .7557 | 25.0 | .8278 | ...... | .30 | .... | ...... | 16 |
| 8.0 | .7008 | 27.0 | .8268 | ...... | .37 | ...... | ...... | 17 |
| 11.5 | .7433 | 30.5 | .8193 | ...... | .48 | ...... | ...... | 18 |
| 14.0 | .7473 | 25.0 | .8216 | ...... | .38 | ...... | ...... | 19 |
| 18.0 | .7211 | 38.0 | .8146 | ...... | .20 | ...... | Oil from first sand. | 20 |
| 18.0 | .7201 | 30.0 | .8071 | ...... | .24 | ...... | ......do. | 21 |

6. Pet. Rev., Nov. 24, 1896, Clifford Richardson.
7-11. Illinois State Geol. Survey, Bull. 2, F. F. Grout, analyst.
13-21. David T. Day, analyst, U. S. Geological Survey.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | ILLINOIS—continued. | | | | | | | |
| | | Cumberland County, Union Township—Con. | | | | | | | |
| 22 | 18 | Underwood lease, sec. 13; Ohio Oil Co. | 17 | 577 | 0.878 | 29.5 | Light green | | 80° C. |
| | | Clark County, Johnson Township: | | | | | | | |
| 23 | 19 | W. D. Misner lease; Pure Oil Co. | 6 | 606 | .863 | 32.2 | do | | 75° C. |
| 24 | 20 | M. Misner lease; Pure Oil Co. | 7 | 610 | .866 | 31.7 | Dark green | | 75° C. |
| 25 | 21 | Z. E. Brant farm, sec. 26; Ohio Oil Co. | 2 | 480 | .868 | 31.3 | Light green | | 75° C. |
| 26 | 22 | Do. | 5 | 474 | .870 | 30.9 | Medium green | | 75° C. |
| | | Crawford County, Robinson pool: | | | | | | | |
| 27 | 1 | Mitchell Oil Co. | 1.2.3. | 950 | .846 | 35.5 | do | | 80° C. |
| 28 | 2 | Graswald lease; G. E. Thomas. | 1 | 970 | .854 | 33.9 | Light green | | 60° C. |
| 29 | 4 | Miller lease; Fisher Oil Co. | 2 | 945 | .871 | 30.7 | do | | 80° C. |
| 30 | 3 | Quick lease; John Markham. | 7 | 960 | .838 | 37.1 | Dark green | | 51° C. |
| | | Crawford County, Montgomery Townthip, Duncansville pool: | | | | | | | |
| 31 | 5 | J. W. Creswell | 1 | 970 | .915 | 23.0 | Brown | | 80° C. |
| 32 | 6 | Higgins lease; M. Bernstein Co. | 1 | 965 | .919 | 22.3 | do | | 75° C. |
| | | Lawrence County, Petty Township, Bridgeport pool: | | | | | | | |
| 33 | 9 | W. E. Neil lease; Braden Oil Co. | 3 | 1,435 | .833 | 38.1 | Light green | | |
| 34 | 8 | Eshelman lease; Bridgeport Oil Co. | 2 | 900 | .854 | 33.9 | Dark green | | 47° C. |
| 35 | 7 | Do. | 4 | 900 | .864 | 32.0 | do | | 70° C. |
| 36 | 10 | Thorn lease; Ohio Oil Co. | 2, 12. | 1,300 | .855 | 33.7 | Medium green | | 75° C. |
| 37 | 11 | Do. | 13, 14, 17 | 1,300 | .855 | 33.7 | do | | 68° C. |
| 38 | 12 | Do. | 8, 10. | 1,300 | .856 | 33.5 | Light green | | 75° C. |
| 39 | 14 | Macpherson lease (100 acres); Kirkwood Oil Co. | 1 | 1,500 | .828 | 39.1 | Dark green | | 45° C. |
| 40 | 15 | Macpherson lease (20 acres); Kirkwood Oil Co. | 1 | 1,500 | .826 | 39.5 | Medium green | | 40° C. |
| | | Martinsville, pipe line, Ohio Oil Co.: | | | | | | | |
| 41 | 33 | Clark County (northern part). | | | .876 | 29.8 | do | | 80° C. |
| 42 | 32 | Cumberland County, Union Township, Siggins pool. | | | .869 | 31.1 | do | | 80° C. |
| 43 | 34 | Clark County (southern part), Johnson Township. | | | .878 | 29.5 | Light green | | 70° C. |
| 44 | 30 | Crawford County | | | .855 | 33.7 | do | | 75° C. |
| 45 | 31 | Lawrence County | | | .847 | 35.3 | do | | 71° C. |
| | | INDIANA. | | | | | | | |
| 46 | .. | Dubois County, Birdseye. | | | .8500 | 34.7 | | | |
| 47 | ... | Jasper County | | | .928 | 20.9 | | 210° C. | |

22-45. David T. Day, analyst, U. S. Geological Survey.

46. Repts. Geol. and Nat. Resources, Indiana, 1903, analysis by chemist of the St. Louis Sampling and testing Works.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | Residuum (cubic centimeters.) | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 10.1 | 0.719 | 34.0 | 0.8215 | ...... | 0.33 | ...... | Lower sand oil contains 8 p. ct. water | 22 |
| 11.5 | .7318 | 35.0 | .8174 | ...... | ...... | ...... | Lower sand oil | 23 |
| 8.0 | .7193 | 32.0 | .8065 | ...... | .30 | ...... | do | 24 |
| 10.5 | .7261 | 30.5 | .8141 | ...... | .27 | ...... | Upper sand oil | 25 |
| 10.0 | .7275 | 33.0 | .8186 | ...... | .24 | ...... | do | 26 |
| 8.0 | .7183 | 39.0 | .7941 | ...... | .16 | ...... | | 27 |
| 16.0 | .733 | 34.0 | .8135 | ...... | .17 | ...... | | 28 |
| 11.5 | .7531 | 32.0 | .8266 | ...... | .19 | ...... | | 29 |
| 20.0 | .7705 | 32.0 | .8107 | ...... | .15 | ...... | | 30 |
| 1.0 | ...... | 24.5 | .8391 | ...... | .39 | ...... | | 31 |
| 4.0 | ...... | 20.0 | .8507 | ...... | .39 | ...... | | 32 |
| 21.0 | .7106 | 33.0 | .811 | ...... | .17 | 5.04 | Lower Bridgeport sand | 33 |
| 15.0 | .7175 | 32.0 | .8211 | ...... | .24 | ...... | Upper sand | 34 |
| 14.5 | .7197 | 31.0 | .8218 | ...... | ...... | ...... | do | 35 |
| 16.5 | .7193 | 31.0 | .794 | ...... | ...... | ...... | Buchanan sand | 36 |
| 16.5 | .7265 | 41.0 | .8193 | ...... | .20 | ...... | do | 37 |
| 14.0 | .7248 | 32.0 | .8188 | ...... | .21 | ...... | do | 38 |
| 21.0 | .7313 | 25.0 | .8103 | ...... | .13 | ...... | | 39 |
| 23.0 | .7113 | 31.5 | .8101 | ...... | .17 | ...... | | 40 |
| 11.0 | .7371 | 29.5 | .8147 | ...... | .26 | ...... | | 41 |
| 13.0 | .7268 | 33.0 | .7983 | ...... | .19 | ...... | | 42 |
| 10.0 | .7326 | 33.0 | .8183 | ...... | .23 | ...... | | 43 |
| 15.0 | .7338 | 37.0 | .8103 | ...... | .17 | ...... | | 44 |
| 15.0 | .7276 | 34.0 | .8053 | ...... | .17 | ...... | | 45 |
| 17.4 | ...... | 26.9 | ...... | 55.5 | ...... | ...... | Lubricating oil, 42.2 p. ct.; residuum, 13.3 p. ct.; sample from Southern Oil Co., Evansville, Ind. | 46 |
| 0 | ...... | 0 | ...... | 97.0 | 1.20 | 2.9 | Cold test, 7° F.; fire test, 437° F | 47 |

47. Repts. Dept. Geol. and Nat. Resources, Indiana, 1903, Mariner and Hoskins, analysts, Chicago.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Gravity. |  | Color. | Flash point. | Begins to distill at— |
|  |  |  |  |  | Specific. | Degrees Baumé. |  |  |  |
|  |  | INDIANA—continued. |  |  |  |  |  |  |  |
| 48 | ... | Jasper County | Refinery run | ........ | 0.9371 | 19.4 | ........ | ........ | 248° F. |
| 49 | ... | Vigo County, Terre Haute. | ........ | ........ | .879 | 29.3 | ........ | ........ | ........ |
| 50 | ... | Grant County, Van Buren. | ........ | ........ | .853 | 34.1 | ........ | ........ | ........ |
|  |  | KANSAS. |  |  |  |  |  |  |  |
|  |  | Wilson County: |  |  |  |  |  |  |  |
| 51 | ... | Neodesha | Main well | ........ | .835 | 37.7 | ........ | ........ | ........ |
| 52 | ... | Do | Kimball well | ........ | .835 | 37.7 | ........ | ........ | ........ |
| 53 | ... | Neosho County, Thayer. | Ordway well | ........ | .849 | 34.9 | ........ | ........ | ........ |
| 54 | ... | Montgomery County, Cherryvale. | Federal Gas and Oil Co. | ........ | .873 | 30.4 | ........ | 32° C. | ........ |
| 55 | ... | Kay County, Newkirk | Well 1, Newkirk Gas and Mineral Co. | ........ | .851 | 34.5 | ........ | 18.4° C. | ........ |
|  |  | KENTUCKY. |  |  |  |  |  |  |  |
| 56 | ... | Lawrence County | Lower Lawrence County well. | 320 | .853 | 34.1 | Brownish black. | ........ | ........ |
| 57 | ... | Warren County, Sunnyside. | ........ | ........ | .8426 | 36.2 | ........ | Ord. t | 67° C. |
|  |  | LOUISIANA. |  |  |  |  |  |  |  |
|  |  | St. Martins Parish: |  |  |  |  |  |  |  |
| 58 | ... | Anse-Le-Butte | Moresi Co. well 2. | 600 | .9392 | 19.1 | ........ | ........ | 240° C. |
| 59 | ... | Bayou Bouillion | Robt. Martin well. | ........ | .859 | 33.0 | Brownish black. | ........ | ........ |
| 60 | ... | Do | ........ | 900 | .9659 | 14.8 | ........ | ........ | 275° C. |
| 61 | ... | Bayou Larompe | Prospect well (not finished). | 400 | .9604 | 15.8 | ........ | ........ | 265° C. |
|  |  | Calcasieu Parish: |  |  |  |  |  |  |  |
| 62 | ... | Jennings | Heywood well | 1,000 | .9093 | 24.0 | ........ | ........ | 200° C. |
| 63 | . | Welsh | ....do | 700 | .9276 | 20.9 | ........ | ........ | 230° C. |
| 64 | ... | Do | ........ | ........ | .938 | 19.3 | Olive green | Over 91° C. | ........ |
|  |  | MICHIGAN. |  |  |  |  |  |  |  |
| 65 | ... | St. Claire County, Port Huron. | ........ | ........ | .8333 | 38.0 | Dark green | ........ | ........ |

48. Repts. Dept. Geol. and Nat. Resources, Indiana, 1904, R. Levering, president, Indiana Asphalt Co.
49, 50. Repts. Dept. Geol. and Nat. Resources, Indiana, 1901, W. A. Noyes, analyst.
51-53. Mineral Resources of Kansas, 1897, Prof. E. H. Bailey, analyst.
54. Pet. Rev., Feb. 2, 1907, Clifford Richardson.
55. Mineral Resources U. S. for 1903, p. 671, Edwin De Barr, of Oklahoma University, analyst.
56. Kentucky Geol. Survey, 1888, Robert Peter, chemist.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| ...... | ...... | ...... | ...... | ...... | ...... | 47.0 | Total distillates obtained when running crude down to asphalt, 49 p. ct.; loss, 4 p. ct. | 48 |
| ...... | ...... | 39.6 | 0.8254 | 60.4 | 0.72 | ...... | 300°-350° C., 14.8 p. ct.; sp. gr., 0.867; 350°-390° C., 40.6 p. ct., sp. gr., 0.879. | 49 |
| 7.2 | 0.719 | 32.6 | .7965 | 60.2 | .83 | ...... | 300°-350° C., 14.8 p. ct.; sp. gr., 0.844; 350°-390° C., 41.8 p. ct.; sp. gr., 0.860. | 50 |
| 19.1 | .7205 | 38.1 | .8081 | 42.8 | ...... | ...... | 14 p. ct. of original quantity remained undistilled; over 300° C., 28.8 p. ct., sp. gr., 0.8691. | 51 |
| 19.8 | .7252 | 34.8 | .8105 | 45.4 | ...... | ...... | 12 p. ct. of original quantity remained undistilled; over 300° C., 33.4 p. ct.; sp. gr., 0.8739. | 52 |
| 16.7 | .7282 | 39.2 | .8093 | 44.1 | | | 12 p. ct. of original quantity remained undistilled; over 300° C., 32.1 p. ct., sp. gr., 0.8663. | 53 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Distillation in vacuo, 20 mm. pressure, 60°-140° C., 16.3 p. ct.; 140°-300° C., 53.9 p. ct. Character of residuum at 200° C., soft, paraffin; 280°-300° C., solid. | 54 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Below 170° C., 9.1 p. ct.; 170°-315° C., 43.75 p. ct.; lubricating oil, 37 p. ct.; solid oil and residuum, 10.15 p. ct. | 55 |
| ...... | ...... | ...... | ...... | ...... | ...... | | Submitted to distillation until 91.4 p. ct. passed over; distillate then fractionally distilled, 160° C., 16.3 p. ct. of original; 160°-320° C., 39 p. ct. | 56 |
| 19.0 | ...... | 37.0 | ...... | 44.0 | ...... | ...... | Volatility in open dish, 150° C. (7 hours), 40.7 p. ct., 100° C., 44.5 p. ct.; 200° C., 58 p. ct. To constant weight, 150° C. (42 hours), 70.6 p. ct.; 160° C. (7 hours), 73.8 p. ct. | 57 |
| ...... | ...... | 16.0 | ...... | 84.0 | .20 | 9.0 | B. t. u. 19,300. When residue heated and evaporated in open dish it was hard, black, shiny, with conchoidal fracture; sp. gr., 1.123. Analysis residuum of asphalt showed volatile, 71 p. ct.; fixed carbon, 28.6 p. ct.; ash, 0.4 p. ct. | 58 |
| 4.3 | ...... | 28.4 | ...... | 67.3 | ...... | ...... | Above 300° C., lubricating oil, 42 p. ct.; asphalt and coke, 15.5 p. ct., loss, 9.8 p. ct. | 59 |
| ...... | ...... | 11.0 | | 89.0 | .57 | ...... | From 300°-350° C., 62 p. ct.; color of fraction, yellow; B. t. u., 18,500; residue, asphaltic. | 60 |
| ...... | ...... | 6.0 | | 94.0 | Low | ...... | From 300°-350° C., 7 p. ct., color of fraction, yellow; residue, asphaltic. | 61 |
| ...... | ...... | 41.0 | | 59.0 | .39 | 5.0 | From 300°-350° C., 24 p. ct.; 350° C. to asphalt, 30 p. ct.; asphalt residue, 5 p. ct.; B. t. u., 19,814. | 62 |
| ...... | ...... | 19.0 | | 81.0 | .32 | ...... | From 300°-350° C., 23 p. ct.; 350° C. to asphalt, 40 p. ct.; asphalt residue, 9 p. ct.; color of fraction, nearly colorless, light yellow on standing. B. t. u., 19,000 | 63 |
| 1.05 | .831 | 30.07 | .852 | 68.88 | | ...... | Lubricating oil, 65.38 p. ct., coke and loss, 3.5 p. ct.; crude free from sulphur; viscosity, 36.8 by Engler's method. | 64 |
| 15.0 | ...... | 55.0 | ...... | 30.0 | | ...... | Lubricating oil, 20 p. ct.; tar, 5 p. ct.; coke, 5 p. ct. (Taken from card reporting production.) | 65 |

57. Pet. Rev., Oct. 27, 1906, Clifford Richardson.
58, 62, 63. Jour. Am. Chem. Soc., vol. 25, p. 1154, C. R. Coates and A. Best, Louisiana State University.
59. Bull. U. S. Geol. Survey No. 282, analysis by Drs. Metz and Custis, Tulane University.
60, 61. Jour. Am. Chem. Soc., vol. 27, p. 1317, C. B. Coates and A. Best.
64. Mineral Resources U. S. for 1905, p. 872, F. C. Thiele, Beaumont, Tex.
65. Mineral Resources U. S. for 1905, p. 879.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | MISSOURI. | | | | | | | |
| 66 | | Cass County, Belton | | | | | | | |
| | | OHIO. | | | | | | | |
| 67 | | Lima | | | 0.791 | 47.0 | Dark green | | 23° C. |
| 68 | | Do | | | .835 | 37.7 | Dark brown, slightly fluorescent. | | |
| 69 | | Do | | | .850 | 34.7 | Dark brown | | |
| 70 | | Do | | | .838 | 37.1 | | | |
| 71 | | Findlay, Peerless Refining Co. | | | .838 | 37.1 | | | |
| | | Washington County: | | | | | | | |
| 72 | | Macksburg | No. 9, Moseley Farm. | From 140-feet sand. | .8118 | 42.5 | Light amber | | |
| 73 | | Do | No. 1, Warren farm. | From 1,500-feet sand. | .8274 | 39.2 | Amber | | |
| 74 | | Do | No. 6, J. S. Dunn farm. | From 500-feet sand. | .7971 | 45.7 | do | | |
| 75 | | Do | McLauth farm. | From 300-feet sand. | .8205 | 40.6 | Peculiar reddish tinge. | | |
| 76 | | Do | Well 1, Moseley farm. | From 700-foot sand. | .8138 | 42.0 | Amber | | |
| 77 | | Archers Fork | Well 1, Ward farm. | Berea grit oil. | .7939 | 46.4 | Light amber | | |
| 78 | | Noble County | | | .8293 | 38.8 | | Ord. t. | 85° C. |
| | | PENNSYLVANIA. | | | | | | | |
| 79 | | (Not located) | | | .8175 | 41.3 | | | 82° C. |
| 80 | | Do. | Pipe line | | .8014 | 44.7 | | Ord. t. | 80° C. |
| 81 | | Do | | | [a].816 | 41.6 | | | |
| 82 | | Do | | | [a].886 | 28.0 | | | |

66. **Mineral Resources U. S. for 1902, p. 566, Prof. Frankforter, University of Minnesota.**
67. Jour. Am. Chem. Soc., vol. 13, p. 168, Mandell and Bourgougnon.
68. Jour. Am. Chem. Soc., vol. 13, p. 179, Durand Woodman.
69. Jour. Am. Chem. Soc., vol. 13, p. 180, Durand Woodman.
70. Jour. Franklin Inst. Nos. 834, 835, C. F. Mabery.
71. Am. Chem. Jour., vol. 17, p. 714, Chas. F. Mabery.
72. Am. Chem. Jour., vol. 18, p. 218, Chas. F. Mabery and Orton C. Dunn.
73. Am. Chem. Jour., vol. 18, p. 221, Chas. F. Mabery and Orton C. Dunn.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 10.0 | ...... | 19.0 | ...... | 71.0 | ...... | ...... | Lubricating oil, 53 p. ct.; residue tar, 10 p. ct.; paraffin, 8 p. ct.; with only a trace of organic matter. | 66 |
| 16.0 | 0.700 | 68.0 | 0.788 | 16.0 | ...... | ...... | Paraffin oil 6 p. ct.; sp. gr., 0.813. | 67 |
| 10.0 | Under .730 | 50.0 | ...... | 40.0 | ...... | ...... | Lubricating oil, 30 p. ct.; sp. gr., 0.830. | 68 |
| ...... | ...... | ...... | ...... | .... | 0.655 | ...... | Gives naphtha and burning oil, 56.8 p. ct.; heavy oil (above 500° F.), 32 p. ct.; residuum, 9.6 p. ct.; water, 0.7 p. ct. | 69 |
| 9.75 | .7282 | 37.13 | .7871 | 52.12 | .37 | | 300°-350° C., 8.63 p. ct.; sp. gr., 0.8242; sulphur, 0.37 p. ct.; bromine absorption, 6.1 p. ct. | 70 |
| 9.75 | .7282 | 37.13 | .7871 | 52.13 | ...... | ...... | Bromine absorption of distillate, 110°-150° C., 0.73 p. ct.; 150°-220° C., 1.74 p. ct.; 220°-257° C., 4.84 p. ct.; 257°-300° C., 5.04 p. ct.; 300°-330° C., 12.10 p. ct. residuum, 19.50 p. ct. | 71 |
| [a]15.47 | ...... | [b]45.81 | ...... | ...... | ...... | ...... | Crude oil, carbon, 85 p. ct.; hydrogen, 13.77 p. ct.; nitrogen, 0.027 p. ct.; bromine absorption, 7.62 p. ct. [a]Up to 160° C.; [b]160°-310° C. | 72 |
| [a]10.64 | ...... | [b]29.17 | ...... | ...... | ...... | ...... | Crude oil, carbon, 85.42 p. ct.; hydrogen, 14.59 p. ct.; nitrogen, 0.064 p. ct.; bromine absorption, 9.96 p. ct. [a]Up to 160° C., [b]160°-310° C. | 73 |
| [a]20.32 | ...... | [b]31.32 | ...... | .... | ...... | ...... | Crude oil, carbon, 84.19 p. ct.; hydrogen, 14.75 p. ct.; nitrogen, 0.015 p. ct.; bromine absorption, 9.46 p. ct. [a]Up to 160° C., [b]160°-310° C. | 74 |
| [a]14.12 | ...... | [b]33.27 | ...... | ...... | ...... | ...... | Crude oil, carbon, 84.45 p. ct.; hydrogen, 13.79 p. ct.; nitrogen, 0.018 p. ct.; bromine absorption, 8.45 p. ct. [a]Up to 160° C.; [b]160°-310° C. | 75 |
| [a]20.69 | ...... | [b]33.08 | ...... | ...... | ...... | ...... | Crude oil, carbon 84.56 p. ct., hydrogen 14.33 p. ct., nitrogen, 0.038 p. ct.; bromine absorption, 5.93 p. ct. [a]Up to 160° C.; [b]160°-310° C. | 76 |
| [a]29.65 | ...... | [b]35.32 | ...... | ...... | ...... | ...... | Crude oil, carbon, 84.35 p. ct.; hydrogen, 14.72 p. ct.; nitrogen, 0.038 p. ct.; bromine absorption, 6.25 p. ct. [a]Up to 160° C.; [b]160°-310° C. | 77 |
| 23.0 | .7297 | 21.0 | .8014 | ...... | .6 | ...... | Crude oil, carbon, 85 p. ct.; hydrogen, 13.80 p. ct.; oxygen and nitrogen, 0.60 p. ct. Distillate, 300°-350° C., 21 p. ct.; sp. gr., 0.8404; refractive index, 1.468; 350°-400° C., 27 p. ct.; sp. gr., 0.8643; refractive index, 1.481. Loss on acid treatment, 5 p. ct.; acid used, 2.5 p. ct. Viscosity by P. R. R. pipette 42. | 78 |
| 21.0 | ...... | 38.25 | ...... | 40.75 | ...... | ...... | ...... | 79 |
| 21.0 | .7188 | 41.0 | .7984 | 37.0 | .06 | ...... | Viscosity by P. R. R. pipette 37. Crude oil, carbon, 86.10 p. ct.; hydrogen, 13.90 p. ct. Percentage acid used, 2. 300°-350° C., 14 p. ct.; sp. gr., 0.8338; refractive index, 1.462. Loss on acid treatment, 150°-300° C., 1.8 p. ct. | 80 |
| [b]20.3 | ...... | [c]59.7 | ...... | ...... | ...... | ...... | [a]Sp. gr. at 0° C.; [b]up to 140° C.; [c]140°-200° C. Composition of crude oil, carbon, 82 p. ct.; hydrogen, 14.8 p. ct.; oxygen, 3.2 p. ct. Heat of combustion, 9,963. | 81 |
| ...... | ...... | [b]12.0 | ...... | ...... | ...... | ...... | [a]Sp. gr., 0° C.; [b]up to 280° C. Composition of crude oil, carbon, 84.9 p. ct.; hydrogen, 13.7 p. ct.; oxygen, 1.4 p. ct. | 82 |

74, 75. Am. Chem. Jour., vol. 18, p. 219. Chas. F. Mabery and Orton C. Dunn.
76. Am. Chem. Jour., vol. 18, p. 220, Chas. F. Mabery and Orton C. Dunn.
77. Am. Chem. Jour., vol. 18, p. 225, Chas. F. Mabery and Orton C. Dunn.
78. Jour. Soc. Chem. Indust., No. 20, Clifford Richardson. Bull. U. S. Geol. Survey, No. 282, 1906.
79. Dingl. Polyt. Jour., vol. 261, pp. 29-34, C. Engler and I. Levin.
80. Jour. Soc. Chem. Indust., No. 20, p. 691, Clifford Richardson and E. C. Wallace.
81, 82. Jour. Am. Chem. Soc., vol. 1, p. 195, A. Bourgougnon.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Gravity. |  | Color. | Flash point. | Begins to distill at— |
|  |  |  |  |  | Specific. | Degrees Baumé. |  |  |  |
|  |  | PENNSYLVANIA—cont'd. |  |  |  |  |  |  |  |
| 83 | ... | (Not located) |  |  | 0.816 | 41.6 |  |  |  |
| 84 | ... | Perry County, Millerstown. |  |  | .790 | 47.2 |  |  |  |
| 85 | ... | Venango County |  |  | 882 | 28.7 | Dark brown |  |  |
|  |  | TEXAS. |  |  |  |  |  |  |  |
|  |  | Jefferson County: |  |  |  |  |  |  |  |
| 86 | ... | Beaumont |  |  | .922 | 21.9 |  | 76.7° C. |  |
| 87 | ... | Do |  |  | .920 | 22.2 |  | 62° C. | 83° C. |
| 88 | ... | Do |  |  | 9115 | 23.6 | Dark green | 54.4° C. |  |
| 89 | ... | Do |  |  | 9217 | 21.9 |  |  |  |
| 90 | ... | Do | Lucas well | 1,200 | .9228 | 21.7 |  |  | 150° C. |
| 91 | ... | Do | Forward Reduction Co. |  | .950 | 17.4 |  |  |  |
| 92 | ... | Do |  |  | .925 | 21.4 |  |  |  |
| 93 | ... | Do | Higgins Fuel and Oil Co. |  | .9103 | 23.8 | Reddish brown | 49° C. |  |
| 94 | ... | Do |  |  | .912 | 23.5 |  |  |  |
| 95 | ... | Do | Lucas well |  | .9206 | 22.1 | Brown opaque |  |  |
| 96 | ... | Do | Lucas |  | .912 | 23.5 |  | Ord. t. | 110° C. |
| 97 | ... | Do | Lucas well | From 1,130-foot sand. | .916 | 22.8 |  |  |  |
| 98 | ... | Do | do | 895-899 | .9218 | 21.9 |  |  |  |
| 99 | ... | Do | do |  | 920 | 22.2 |  |  |  |
|  |  | Bexar County: |  |  |  |  |  |  |  |
| 100 | ... | San Antonio | Walsh well |  | 88 | 29.1 | Reddish brown | 37° C. |  |
| 101 | ... | Do | Dulling well |  | .9179 | 22.5 | do | 73° C. |  |
|  |  | Hardin County: |  |  |  |  |  |  |  |
| 102 | ... | Batson | Refining sample, United Oil and Refining Co., Beaumont. |  | .8878 | 27.7 |  |  |  |

83. Jour. Soc. Chem. Indust., No. 19, p. 123, analysis by Bolley.
84. Jour. Am. Chem. Soc., vol. 1, p. 204, A. Bourgougnon.
85. Hist. of Petroleum, by J. T. Henry; analysis by Prof. B. Silliman.
86. Mineral Resources U. S. for 1901, p. 571, Sir Boverton Redwood.
87. Mineral Resources U. S. for 1901, p. 571, J. E. Denton, (a) Richardson and Wallace.
88. Chem. Trade Jour., Mar. 2, 1901, Emery Mfg. Co., Bradford, Pa.
89. Bull. U. S. Geol. Survey, No. 282, 1906, United Oil and Refining Co., Beaumont.
90. Jour. Am. Chem. Soc., vol. 25, p. 1154, C. R. Coates and Alfred Best.
91. Jour. Am. Chem. Soc., vol. 22, p. 551, Chas. F. Mabery and D. M. Buck.
92. Texas Univ. Min. Survey, Bull. 1, p. 76, Ledoux & Co., New York, analyst.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). To 150° C. Cubic centimeters. | Specific gravity. | 150°-300° C. Cubic centimeters. | Specific gravity. | Residuum (cubic centimeters). | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| 19.7 | ...... | 44.77 | 0.792 | 35.52 | ...... | ...... | (Article written by Clifford Richardson) | 83 |
| 17.0 | 0.693 | 43.0 | .765 | 40.0 | ...... | ...... | Separated into 100 fractions; percentages, 17, 43, 40 are approximate; residuum, 10 p. ct. | 84 |
| 8.55 | ...... | [a]42.78 | ...... | [b]48.67 | ...... | ...... | [a]150°-270° C.; [b]includes loss and water | 85 |
| ...... | ...... | ...... | ...... | ...... | 1.33 | ...... | Viscosity, Redwood standard (188 seconds), 33.3 at 15.5° C.; fluid at 0° F. Carbonaceous residue on distillation to dryness, 4.40 p. ct.; caloric value, B. t. u., 19,388. | 86 |
| ...... | ...... | ...... | ...... | ...... | 1.75 | ...... | Carbon, 84.60 p. ct.; hydrogen, 10.90 p. ct.; oxygen and nitrogen, 2.87 p. ct. Cold test, 6° F.; calorific value, B. t. u., 19,060. [a]Loss in treatment with excess of $H_2SO_4$, 39 p. ct. Carbon, 85.03 p. ct.; hydrogen, 12.30 p. ct. | 87 |
| 3.12 | ...... | 12.5 | ...... | 84.38 | ...... | ...... | No evidence of congealing at 5° F.; 4 gallons distilled gravity of first 10 pint samples of distillates, 38.9° B., 33.1° B., 32.6° B., 31.6° B., 30.8° B., 29.3° B., 28.6° B., 27.6° B., 26.7° B. Fuel oil, 78.12 p. ct. | 88 |
| 1.8 | ...... | 17.1 | ...... | 81.1 | ...... | 7.5 | Solar oil, 15.4 p. ct.; lubricating oil, 52.2 p. ct | 89 |
| ...... | ...... | 36.0 | ...... | 64.0 | 1.96 | 8.0 | 300°-350° C., 26 p. ct.; 350° to asphalt, 30 p. ct. Large quantities $H_2S$ evolved 115°-150° C.; B. t. u., 19,923. | 90 |
| ...... | ...... | ...... | ...... | ...... | .94 | ...... | Distilled in vacuo under 13 mm. pressure; up to 150° C., 10 p. ct.; sp. gr., 0.8753; 150°-230° C., 32 p. ct.; sp. gr., 0.9222; 230°-300 °C., 21 p. ct.; sp. gr., 0.9602; above 300° C., 37 p. ct. (very thick). Sulphur by Carius method. | 91 |
| [a]6.0 | .851 | [b]41.5 | .8798 | 52.5 | 2.04 | ...... | [a]Up to 200° C.; [b]200°-300° C. | 92 |
| 2.9 | .7938 | 39.8 | .8759 | 57.3 | 2.40 | ...... | B. t. u., 19,785. Heavy oil, 42.6 p. ct.; sp. gr., 0.9078; residue, 7.6 p. ct.; loss, 7 p. ct. Distillates above 617° C., 36.8 p. ct.; sp. gr., 0.9094. | 93 |
| ...... | ...... | 33.7 | ...... | ...... | ...... | ...... | 300°-360° C., 7.5 p. ct | 94 |
| 6.45 | ...... | 35.0<br>36.0 | .872 | 58.55<br>64.0 | ...... | 6.34 | Test of kerosene, color, prime white, flash point, 120° F.; light lubricating, 21.05 p. ct.; medium lubricating, 21.05 p. ct.; heavy lubricating, 10.52 p. ct.; loss, gas, and sulphur, 5.04 p. ct. | 95 |
| 2.5 | ...... | 40.0 | .8749 | 57.5 | 1.75 | ...... | Ultimate composition: carbon, 85.03 p. ct.; hydrogen, 12.30 p. ct.; oxygen and nitrogen, 0.92 p. ct. Loss on treatment with excess $H_2SO_4$, 39 p. ct. Volatility in open dish (7 hours), 110° C., 19.19 p. ct.; 162° C., 31.31 p. ct.; 205° C., 57.57 p. ct. | 96 |
| [a]1.78 | ...... | [b]44.08 | ...... | 51.14 | ...... | ...... | [a]To 100° C.; [b]100°-300° C.; residue, 4.24 p. ct.; loss, 3.26 p. ct. | 97 |
| [a]1.96 | ...... | [b]53.77 | ...... | 44.27 | ...... | ...... | [a]To 100° C.; [b]100°-300° C.; residue, 3.33 p. ct.; loss, 3.86 p. ct. | 98 |
| ...... | ...... | ...... | ...... | ...... | 2.16 | ...... | Distilled under atmospheric pressure, 145°-200° C., 4 p. ct.; 200°-250° C., 11 p. ct. Distilled under 14 mm. pressure, 95°-100° C., 17 p. ct.; 150°-200° C., 17 p. ct.; 200°-250°, 51 p. ct.; residue, 15 p. ct. Nitrogen more than 1 p. ct. | 99 |
| 4.73 | .745 | 36.90 | .8117 | 59.37 | 2.02 | ...... | Residue, 10 p. ct.; loss, 0.30 p. ct.; fraction up to 250° C., colorless. | 100 |
| 1.10 | ...... | [a]27.30 | ...... | 71.00 | 1.52 | ...... | [a]150°-275° C.; residue, 8.40 p. ct., loss, 2.20 p. ct | 101 |
| 6.5 | ...... | 20.4 | ...... | 73.1 | ...... | 6.0 | 14.4 p. ct. solar oil, 46.7 p. ct. lubricating oil | 102 |

93. Texas Univ. Min. Survey, Bull. 1, p. 74, O. H. Palm, analyst.
94. Texas Univ. Min. Survey, Bull. 1, p. 75, Prof. L. W. Wilkinson, Tulane University, New Orleans, La.
95. Jour. Franklin Inst., Sept., 1902, Prof. F. C. Thiele.
96. Jour. Soc. Chem. Indust., 1900, vol. 20, p. 691, Richardson and Wallace.
97, 98. Texas Univ. Min. Survey, Bull. 1, p. 72, E. P. Shock, analyst.
99. Jour. Am. Chem. Soc., vol. 23, p. 264, Chas. F. Mabery.
100. Texas Univ. Min. Survey, Bull. 1, p. 51, O. H. Palm, analyst.
101. Texas Univ. Min. Survey, Bull. 1, p. 51, S. H. Worell.
102. Bull. U. S. Geol. Survey, No. 282, N. M. Fenneman.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | TEXAS—continued. | | | | | | | |
| | | Hardin County—Con. | | | | | | | |
| 103 | | Sour Lake | | | 0.963 | 15.4 | | | |
| 104 | | Do | | | .9494 | 17.5 | Reddish brown. | 118° C. | |
| 105 | | Jack County | | | .921 | 22.0 | Blackish brown | | 137° C. |
| 106 | | Medina County, Dunlay. | | | .9031 | 25.0 | Reddish brown. | 110° C. | 172° C. |
| 107 | | McLennan County, Waco. | | | .8432 | 36.0 | | | |
| | | Navarro County: | | | | | | | |
| 108 | | Corsicana | | | | | | | 80° C. |
| 109 | | Do | | | .8604 | 32.7 | Dark brown | 22.8° F | 77° C. |
| 110 | | Do | | | .8292 | 38.8 | Very dark brown, opaque. | | 54.4° C |
| 111 | | Do | | | .8493 | 34.8 | Dark reddish brown, green fluorescence. | Ord. t. | 57° C. |
| 112 | | Do | | | | | | | |
| 113 | | Pecos County, Fort Stockton. | | | .925 | 21.4 | Very dark brown, opaque. | | |
| 114 | | Reeves County, Toyah | | | .9126 | 23.4 | Dark brown | 74° C. | |
| 115 | | Travis County, Watters Park. | | | .9708 | 14.2 | Black; brown in thin layers. | (a) | |
| | | UTAH. | | | | | | | |
| | | Washington County: | | | | | | | |
| 116 | | Virgin River | | | .9116 | 23.6 | | | |
| 117 | | Do | | | .9144 | 23.1 | | | |
| 118 | | Do | | | .915 | 23.0 | | | |
| | | WYOMING. | | | | | | | |
| 119 | | Norwood Spring | | | .8822 | 28.7 | | | |
| | | Big Horn County: | | | | | | | |
| 120 | | Bonanza Field (from a spring Jan. 1902). | T. 49 N., R. 91 W. | | .845 | 35.7 | Bright green; red by transmitted light. | Below 30° C. Ord. t. | |
| 121 | | Bonanza Field (same spring Sept. 24, 1902). | do | | .850 | 34.7 | do | 26° C. | |
| 122 | | Bonanza Field | Henderson Well, sec. 13, T. 49 N., R. 91 W. | | .8446 | 35.8 | Strong green fluorescence, color red | 13° C | |

103. Am. Chem. Jour., vol. 22, p. 489, F. C. Thiele; Texas Univ. Min. Survey, Bull. 1, p. 43.
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105. Texas Univ. Min. Survey, Bull. 1, p. 34, A. L. Metz, analyst, Tulane University, New Orleans, La.
106. Texas Univ. Min. Survey, Bull. 1, p. 52, O. H. Palm, analyst.
107. Texas Univ. Min. Survey, Bull., 1, p. 5, D. E. Everhart, analyst.
108. Texas Agri. Exper. Sta., Bull. 11. Mineral Resources U. S. for 1897, p. 848.
109. Texas Univ. Min. Survey, Bull. 1, p. 48, Dr. W. H. Harper, analyst.
110. Texas Univ. Min. Survey, Bull. 1, p. 49, E. H. Earnshaw, analyst.
111. Jour. Soc. Chem. Indust., vol. 19, p. 121, Clifford Richardson.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| [a]0.1 | ...... | 21.08 | 0.8282 | 78.82 | ...... | 20.0 | [a] To 160° C. | 103 |
| 6.6 | [a]0.8693 | [b]15.3 | 8974 | [c]78.1 | ...... | ...... | [a]At 20° C.; [b] 150°-175° C.; [c] reddish brown maltha, very sticky. Refractive indices, [a]1.474, [b]1.489, [c]1,500. | 104 |
| .88 | ...... | 17.53 | .8399 | 81.59 | ...... | ...... | 300° C. up, 68.99 p. ct.; asphalt and coke, 12.60 p. ct. Special precaution against cracking. Result of redistillation of distillate also given by which gasoline and illuminating oil product increased by cracking. | 105 |
| 6.10 | .7519 | 29.94 | .8330 | 63.96 | 2.09 | ...... | Residuum semisolid asphalt; 13.50 p. ct. of distillate colorless. | 106 |
| [a]1.39 | ...... | [b]40.03 | ...... | [c]58.58 | ...... | ...... | [a] Up to 205° C.; [b] between 205° C. and 271° C.; [c] principally paraffin and paraffin oil. | 107 |
| [a]34.6 | ...... | [b]40.0 | ...... | 25.4 | ...... | ...... | [a] Up to 140° C.; [b] 140°-305° C. Above 305° C., 15.8 p. ct.; coke residue, 9.6 p. ct. | 108 |
| [a]24.78 | .755 | [b]59.94 | ...... | 15.28 | ...... | ...... | [a] Portion of fraction 77-203° F. lost before measured; [b] 150°-280° C. Up to 150° C. distillate colorless. | 109 |
| [a]15.5 | .7090 | [b]39.75 | .7881 | 44.75 | ...... | ...... | [a] To 149° C.; [b] to 288° C. Distillate colorless up to 500° C. | 110 |
| [a]28.0 | .7819 | [b]15.8 | .8244 | 56.2 | ...... | ...... | [a] To 151° C.; [b] 151°-180° C., distilled at 25 mm. pressure. Volatile: 100° C., 10.8 p. ct. naphtha; 162° C., 35.7 p. ct. naphtha; 204° C., 11.2 p. ct. naphtha. Cracking begins 175° C. | 111 |
| 10.8 | .710 | 54.5 | .796 | 34.7 | ...... | ...... | ...... | 112 |
| ([a]) | ...... | ([b]) | ...... | ...... | ...... | ...... | [a] To 200° C.; [b] 200°-360° C. Distillate above 360° C., 27.02 p. ct.; residue, 45.54 p. ct., loss, 2.68 p. ct. | 113 |
| 16.0 | .7404 | 24.60 | .8466 | 69.3 | 1.00 | ...... | Oil flows at 3° F.; burning point, 230° F. B. t. u. 19,440. 325°-350° C., 50 p. ct. heavy oil, loss, 5.3 p. ct.; residue, 14 p. ct. by weight. Viscosity by Engler method 20 at 23° C. | 114 |
| ...... | ...... | 58.1 | .9144 | ...... | 1.26 | ...... | B. t. u. 18,835. Distillation, 35 mm. pressure. Residue, ivory black, brilliant luster, sticky. [a] Does not flash. | 115 |
| 0 | ...... | 30.63 | ...... | 69.37 | ...... | ...... | Lubricating oil, 43 p. ct.; coke and loss, 26.37 p. ct. | 116 |
| ...... | ...... | ...... | ...... | ...... | 1.38 | ...... | Kerosene, 52° B., 8 p. ct.; neutral oil, 35.3° B., 20 p. ct.; 36.1° B., 40 p. ct.; 33° B., 23 p. ct. Residuum containing considerable paraffin, 9 p. ct. | 117 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Kerosene, 11.8 p. ct.; heavy signal oil, 9.5 p. ct.; light lubricating oil, 9 p. ct.; heavy lubricating oil, 55.9 p. ct.; paraffin, 3.4 p. ct.; residuum, 7.7 p. ct, loss 2.1 p. ct. | 118 |
| [a]5.07 | .8051 | [b]75.33 | .8421 | 19.60 | ...... | ...... | [a] 26°-130° C.; [b] 130°-260° C. | 119 |
| 10.0 | .736 | [a]50.0 | .8194 | 40.0 | .0149 | ...... | 13° F. added on account of altitude of Laramie, Wyo. [a] 150°-310° C. 300 c. c. distilled in 10 fractions 30 c. c. each. | 120 |
| [a]10.0 | .762 | [b]40.0 | .8275 | 50.0 | ...... | ...... | [a] 67°-164° C.; [b] 164°-304.5° C. 13° F. added on account of altitude of Laramie, Wyo. 280 c. c. distilled in 10 fractions. | 121 |
| [a]10.0 | .736 | [b]50.0 | ...... | 40.0 | ...... | ...... | Paraffin 2 to 4 p. ct. [a] 80°-142° C.; [b] 142°-303° C. | 122 |

112. Am. Chem. Jour., vol. 22, p. 489, F. C. Thiele, analyst.
113. Texas Univ. Min. Survey, Bull. 1, p. 53, O. H. Palm, analyst.
114. Texas Univ. Min. Survey, Bull. 9, p. 66, O. H. Palm, analyst.
115. Texas Univ. Min. Survey, Bull. 15
116, 117. The Tribune, Dec. 29, 1907, Salt Lake City, Utah.
118. Deseret Evening News, Salt Lake City, Utah, Dec. 14, 1907.
119. Report Wyoming Ter. Geologist, 1887, Louis D. Ricketts, W. H. Kent, analysts.
120, 121, 123-125. Univ. Wyoming, Bull. 6, Prof. E. E. Slosson, analyst.
122. Wyoming Mines and Minerals, 1904, Prof. E. E. Slosson, analyst.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | **WYOMING—continued.** | | | | | | | |
| | | Big Horn County—Con. | | | | | | | |
| 123 | ... | Cottonwood........ | T. 47 N., R. 90 W. | ........ | 0.902 | 25.2 | Brownish red by transmitted light; dark green by reflected light. | ........ | ........ |
| | | Converse County: | | | | | | | |
| 124 | ... | Douglas........... | ........ | ........ | .961 | 15.7 | ........ | 164° C. | ........ |
| 125 | ... | Do........ | ........ | ........ | .921 | 22.0 | ........ | ........ | ........ |
| | | Crook County: | | | | | | | |
| 126 | ... | Belle Fourche...... | Well........ | | .915 | 23.0 | Bright red by transmitted light; dark green by reflected. | 123° C. | ........ |
| 127 | ... | Moorecroft......... | Butte Crude Petroleum Co. | ........ | .939 | 19.1 | ........ | ........ | ........ |
| | | Fremont County: | | | | | | | |
| 128 | ... | Lander............. | Washakie spring. | ........ | .8725 | 30.5 | Bright red by transmitted light; green by reflected light. | 77° C. | ........ |
| 129 | ... | Popo Agie, near Lander. | ........ | ........ | .900 | 25.6 | Almost black; red-brown by transmitted light. | 32° C. | 95° C. |
| 130 | ... | Shoshone Basin.... | ........ | ........ | .911 | 23.7 | ........ | ........ | ........ |
| 131 | ... | Do........ | ........ | ........ | .945 | 18.2 | ........ | ........ | ........ |
| 132 | ... | Shoshone Field..... | ........ | ........ | .996 | 10.6 | Black and thick. | ........ | ........ |
| 133 | ... | Do........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 134 | ... | Do........ | ........ | ........ | .966 | 14.9 | ........ | ........ | ........ |
| | | Natrona County: | | | | | | | |
| 135 | ... | Rattlesnake Basin . | ........ | ........ | .992 | 11.1 | Black........ | ........ | ........ |
| 136 | ... | Salt Creek.......... | Pa. Oil Co. wells. | ........ | .9095 | 23.9 | Bright red by transmitted light, dark green by reflected light. | 210° C. | ........ |
| 137 | ... | Do........ | ........ | ........ | ........ | ........ | Green........ | ........ | ........ |
| 138 | ... | Oil Mountain district. | Spring........ | ........ | .910 | 23.8 | Bright green.... | 112° C. | 207° C. |
| | | Uinta County: | | | | | | | |
| 139 | ... | Spring Valley...... | Union Pac. well. | ........ | ........ | ........ | ........ | ........ | ........ |
| 140 | ... | Do........ | ....do........ | ........ | .8211 | 40.5 | ........ | ........ | ........ |
| 141 | ... | Do........ | ....do........ | ........ | .810 | 42.8 | ........ | Below 70° C. | ........ |

126. Univ. Wyoming, Bull. 3, Prof. E. E. Slosson.
127. From 1906 statistical card, U. S. Geol. Survey.
128, 132. Univ. Wyoming, Bull. 2, Prof. E. E. Slosson.
129. Univ. Wyoming, Bull. 2, Prof E. E. Slosson. Mineral Resources U. S. for 1897.
130, 131. Jour. Soc. Chem. Indust., No. 6, p. 408, Sir Boverton Redwood.
133, 134. Report Wyoming Ter. Geologist, 1886, Wyner and Harland, analysts, London, England.
135. Report Wyoming Ter. Geologist, 1886, Wyner and Harland, analysts, London, England.

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*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°–300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| [a]10.0 | ...... | [b]40.0 | ...... | 50.0 | ...... | ...... | [a] To 164° C.; [b] 164°–305.5° C. | 123 |
| ...... | ...... | [a]9.81 | 0.884 | 90.19 | ...... | ...... | [a] 179.2°–315° C. 13° F. added on account of altitude of Laramie, Wyo. 480.5 grams distilled, which contained 30 grams of water. | 124 |
| ...... | ...... | [a]54.6 | .8689 | 45.4 | ...... | ...... | Oil sand retorted and oil distilled. 13° F. added on account of altitude of Laramie, Wyo. [a] 177.2°–297.2° C. | 125 |
| ...... | ...... | [a]22.38 | .8485 | 77.62 | 0.303 | ...... | [a] Up to 297° C.; burning point, 149° C. Viscosity by Engler method, 37.7 at 20° C.; freezing point, 0° C. | 126 |
| 3.0 | ...... | 40.0 | ...... | 57.0 | ...... | ...... | (Analysis made by Von Schulz & Son, Denver, Colo.). | 127 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Sample had been weathered and had lost some of its lighter constituents. Viscosity 1.55 at 20° C., Engler method. | 128 |
| 2–5 | ...... | 30–40 | .810–.830 | ...... | .66 | ...... | Fire test 58° C.; viscosity by Engler method, 13.28 at 20° C. Lubricating oil, sp. gr. 0.910–0.940, 35 to 40 p. ct.; paraffin, 3 to 5 p. ct.; coke, 7 to 10 p. ct. | 129 |
| 2.5 | ...... | 27.5 | ...... | ...... | ...... | ...... | Lubricating oil 52.5 p. ct., sample 6. | 130 |
| 0 | ...... | 10.0 | ...... | ...... | ...... | ...... | Lubricating oil 72.5 p. ct., sample 7. | 131 |
| 0 | ...... | ...... | ...... | ...... | ...... | ...... | Only small quantity distilled; water in sample so that flash point not determined. | 132 |
| 0 | ...... | 17.0 | .807 | 83.0 | ...... | ...... | Lubricating oil, sp. gr. 0.810-0.824, 21 p. ct.; sp. gr. 0.840-0.844, 20 p. ct.; sp. gr. 0.906, 27 p. ct. Coke, 14 p. ct. | 133 |
| 0 | ...... | ...... | ...... | ...... | ...... | ...... | Lubricating oil, sp. gr. 0.842-0.847, 19 p. ct.; sp. gr. 0.926-0.935, 45 p. ct.; sp. gr. 0.957, 12.5 p. ct. Coke, 14.5 p. ct.; loss, 9 p. ct. | 134 |
| ...... | ...... | ...... | ...... | 100 | ...... | ...... | Lubricating oil, sp. gr. 0.854-0.860, 29.80 p. ct.; sp. gr. 0.933, 7.40 p. ct.; sp. gr. 0.950, 23 p. ct. Coke, 30 p. ct. | 135 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Distillations made in various ways. Viscosity at 20° C., 15.74, Engler method. | 136 |
| 1.2 | 0.739 | 12.133 | .8313 | 86.667 | ...... | ...... | Lubricating oil, 76.765 p. ct.; coke, 3.0075 p. ct.; ash, 0.148 p. ct.; loss, 6.4816 p. ct. | 137 |
| ...... | ...... | [a]5.0 | .860 | 95.0 | .10 | ...... | [a] 207°–307° C. Flash, 104° C.; fractionated into 20 portions. | 138 |
| 28.0 | ...... | 24.0 | ...... | 48.0 | ...... | ...... | Signal oil, 8 p. ct.; lubricating oil 23 p.ct.; paraffin, 17 p. ct. | 139 |
| 19.0 | ...... | 35.0 | ...... | 46.0 | ...... | ...... | Lubricating oil, 42 p. ct.; coke, 1.8 p. ct.; loss, 2 p. ct. Sample taken June 29, 1902, from car loaded Jan. 26, 1902. | 140 |
| 20–30 | ...... | 30–40 | ...... | ...... | ...... | ...... | Paraffin, 10–20 p. ct. Fraction, 77°–130° C., sp. gr. 0.723; 130°–170° C., sp. gr. 0.754; 170°–200° C., sp. gr. 0.780; 200°–259° C., sp. gr. 0.804. | 141 |

136. Univ. Wyoming, Bull. 1, Prof. E. E. Slosson.
137. Mineral Resources U. S. for 1894, analysis by Prof. Wilbur C. Knight, Wyoming.
138. Univ. Wyoming, Bull. 4, Prof. E. E. Slosson.
139. Bull. U. S. Geol. Survey No. 285, analysis by Theo. Price & Son, San Francisco, Cal.
140. Bull. U. S. Geol. Survey No. 285, G. W. Gray, analyst.
141. Bull. U. S. Geol. Survey No. 285, p. 352.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | WYOMING—continued. | | | | | | | |
| | | Uinta County—Con. | | | | | | | |
| 142 | | Spring Valley | Union Pac. well. | At 650 feet, sand. | 0.825 | 39.7 | | 19° C. | |
| 143 | | Do. | Pittsburg-Salt Lake oil well. | | .810 | 42.8 | | | |
| 144 | | Do. | | | .8329 | 38.1 | Olive green. | Below 15.5° C. | |
| 145 | | Do. | | | .8176 | 41.2 | | Below 19° C. | |
| 146 | | Carter district | Spring | | .924 | 21.5 | Black | 140° C. | |
| 147 | | Twin Creek district | do | | .935 | 19.7 | do | 141° C. | |
| | | Weston County: | | | | | | | |
| 148 | | Newcastle | Spring near B. & M. Rwy. | | .923 | 21.7 | Red-brown by transmitted light, dark green by reflected light, opaque and viscous. | | |
| 149 | | Do. | American spring. | | .920 | 22.2 | Red-brown by transmitted light. | 135° C. | |
| 150 | | Do. | Middle spring | | .916 | 22.8 | Red-brown by transmitted light, opaque and viscous. | 131° C. | |
| 151 | | Do. | Eagle spring | | .9168 | 22.7 | Red-brown by transmitted light, opaque and viscous. | 122° C. | |
| | | CALIFORNIA. | | | | | | | |
| 152 | | | | | .835 | 37.7 | Dark brown, opaque. | | |
| 153 | | Colusa County | | | .8257 | 39.6 | Yellow | | |
| 154 | | Do. | | | .9835 | 12.3 | | | |
| 155 | | Do. | | | .9534 | 16.8 | | | |
| 156 | | Do. | | | .9635 | 15.3 | | | |
| 157 | | Contra Costa County | | | .9667 | 14.8 | Black | | |
| | | Fresno County: | | | | | | | |
| 158 | | Coalinga | Tank average, Oil City. | | .8568 | 33.4 | Green | | |
| 159 | | Do. | Tank average, top sand oil. | | .8974 | 26.0 | Black | | |
| 160 | | Do. | Pipe-line average. | | .9296 | 20.6 | | | |
| 161 | | Do. | Pipe line average, Ora crude. | | .9321 | 20.2 | | | |
| 162 | | Do. | | | .8537 | 34.0 | | | |
| 163 | | Do. | | | .852 | 34.3 | | | |

142. Bull. U. S. Geol. Survey No. 285, Louis Falkenau, analyst, San Francisco, Cal.
143. Bull. U. S. Geol. Survey No. 285, C. F. Mabery, Cleveland, Ohio, analyst.
144. Mineral Resources U. S. for 1902, Dr. F. Salathe, analyst.
145. Mineral Resources U. S. for 1902, Wilbur C. Knight, State geologist, Wyoming.
146, 147. Univ. Wyoming, Bull. 3, Prof. E. E. Slosson, analyst.
148–151. Univ. Wyoming, Bull. 5, Prof. E. E. Slosson, analyst.
152. Jour. Am. Chem. Soc., 1891, D. Woodman.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | Residuum (cubic centimeters). | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
| $^a$15.0 | 0.740 | $^b$33.1 | 0.802 | 49.5 | ..... | ...... | $^a$ 19°-150° C.; $^b$ 150°-255° C. 255°-317° C., 27.1 p. ct; sp. gr. 0.830; bituminous soluble, 1 p. ct.; carbon and ash, 1 p. ct. | 142 |
| 21.3 | .7179 | $^a$39.7 | .8046 | 39.0 | 0.03 | ...... | $^a$ 150°-305° C. 305°-350° C., 16.4 p. ct.; paraffin, 6.2 p. ct.; residue, 7.2 p. ct. Oil begins to crack at 350° C. | 143 |
| 27.0 | ...... | 25.5 | ...... | 47.5 | ..... | ...... | Signal oil, 7 p. ct.; lubricating oil, 40.5 p. ct. | 144 |
| ...... | ...... | ...... | ...... | ...... | ..... | ...... | Sample taken at first strike, fractional distillations 10 parts: 77°-130° C., 130°-170° C., 170°-200° C., 200°-259° C., 259°-292° C., 292°-320° C., 320°-350° C., 350°-370° C., 370°-380° C., 380°-400° C. Paraffin, 10-15 p. ct. | 145 |
| ...... | ...... | ...... | ...... | ...... | .10 | ...... | Freezing point, 0° C. 277°-357° C., 41.9 p. ct.; sp. gr. 0.866, color dark red; 357°-372° C., 38.1 p. ct; sp. gr. 0.867, color opaque. | 146 |
| ...... | ...... | ...... | ...... | ...... | .00 | ...... | 277°-344° C., 54 p. ct.; sp. gr. 0.881; flash point, 62° C.; burning point, 97° C. | 147 |
| ...... | ...... | ...... | ...... | ...... | ..... | ...... | Fractionally distilled into 10 portions: 107°-267° C., 267°-319° C., 319°-355° C., 355°-372° C., 372°-383° C., 383°-389° C., 389°-395° C., 395°-407° C. Contains paraffin. | 148 |
| ...... | ...... | ...... | ...... | ...... | ..... | ...... | Fractionally distilled into 10 portions: 107°-303° C., 303°-319° C., 319°-353° C., 353°-367° C., 367°-374° C., 374°-375° C., 375°-337° C., 337°-379° C., 379°-382° C., 382°-352° C. Contains paraffin. | 149 |
| ...... | ...... | ...... | ...... | ...... | ..... | ...... | Fractionally distilled: 117°-277° C., 277°-327° C., 327°-353° C., 353°-367° C., 367°-375° C., 375°-382° C., 382°-394° C. Contains paraffin. | 150 |
| ...... | ...... | ...... | ...... | ...... | ..... | ...... | Burning point, 153° C. Fractionally distilled 20 portions, sp. gr. of first 8 fractions as follows: 0.868, 0.874, 0.881, 0.888, 0.892, 0.897 0.897, 0.897; color light yellow. Viscosity by Engler method at 15.5° C., 29.43. | 151 |
| 10.0 | .730 | 40.0 | ...... | 50.0 | .18 | ...... | Lubricating oil, 40 p. ct.; residuum, 10 p. ct. | 152 |
| ...... | ...... | $^a$77.8 | ...... | ...... | .50 | 0.50 | $^a$ 150°-350° C. | 153 |
| 0.0 | ...... | 16.25 | .9111 | 83.75 | ..... | ...... | Sample contained sludge (sample B). Sample A not specific enough to quote. | 154 |
| Tr. | ...... | 21.6 | .8533 | 78.4 | ..... | ...... | 300°-350° C., 3 p. ct. Sample contained sludge. | 155 |
| 0 | ...... | $^a$19.0 | ...... | 81.0 | ..... | ...... | $^a$ 150°-270° C. Maumene No. 0.306. | 156 |
| 3.7 | ...... | $^a$54.5 | ...... | 42.8 | ..... | 21.0 | $^a$ 150°-350° C. | 157 |
| ($^a$) | ...... | ...... | ...... | ...... | ..... | ...... | Gasoline, 2.3 p. ct.; engine distillate, 22.3 p. ct.; kerosene, 28.6 p. ct.; stove oil, 10.3 p. ct.; gas oil, 9.9 p. ct. $^a$ Temperature not given. | 158 |
| ($^a$) | ...... | ...... | ...... | ...... | ..... | 17.0 | Gasoline, benzine, and distillate, 12.38 p. ct.; kerosene and stove oil, 30.30 p. ct. $^a$ Temperature not given. | 159 |
| ($^a$) | ...... | ...... | ...... | ...... | ..... | 13.34 | Gasoline and benzine, 3.89 p. ct.; kerosene and stove oil, 13.35 p. ct. $^a$ Temperature not given. | 160 |
| ($^a$) | ...... | ...... | ...... | ...... | ..... | 22.7 | Engine distillate, 4.34 p. ct.; kerosene, 41.3 p. ct.; $^a$ Temperature not given. | 161 |
| 32.6 | .800 | 43.6 | .8372 | 23.8 | ..... | ...... | 300°-350° C., 12 p. ct., sp. gr. 0.9001. | 162 |
| 32.6 | .800 | $^a$44.2 | .8488 | 23.2 | ..... | ...... | $^a$ 150°-250° C.; 250°-320° C., 12 p. ct., sp. gr. 0.911 | 163 |

153, 157, 169-171. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill, University of California.
154. California State Min. Bur., Bull. 19, by M. L. Watts.
155. California State Min. Bur., Bull. 19.
156. Mineral Resources U. S. for 1903, p. 178, Paul W. Prutzman, analyst.
158-161. California State Min. Bur., Bull. 31.
162. California State Min. Bur., Bull. 19, p. 204.
163. California State Min. Bur., Annual Rept. 1894, p. 352.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Fresno County—Con. | | | | | | | |
| 164 | | Coalinga | | | 0.988 | 11.7 | | | |
| 165 | | Do | M., K. & T. Oil Co. | | .959 | 16.0 | | 120° C. | |
| 166 | | Do | | | | | | | |
| 167 | | Do | From spring south of Coalinga. | | .974 | 13.7 | | | |
| 168 | | Do | | | .7609 | 54 | | | 49° C. |
| 169 | | Do | | | .9028 | 25.1 | Brown | | |
| 170 | | Do | | | .951 | 17.2 | do | | |
| 171 | | Do | | | .9320 | 20.2 | do | 70° C. | |
| 172 | | Do | | | .8459 | 35.5 | Greenish | | |
| 173 | | Do | Well 2, California Oilfield Ltd. | 1,020 | .9150 | 23.0 | | Below 15° C. | |
| 174 | | Do | No. 11, California Oilfield, Ltd. | 1,125 | .868 | 31.3 | | Below 15° C. | |
| 175 | | Do | R. C. Baker well. | 560 | .9750 | 13.5 | | Above 70° C. | |
| 176 | | Do | Blue Goose No. 3, Home Oil Co. | 1,350 | .8530 | 34.1 | | Below 15° C. | |
| 177 | | Do | Well 14, T. 20 S., R. 14 E. | | .9831 | 12.4 | | | |
| 178 | | Do | Well 24, T. 20 S., R. 14 E. | | .9609 | 15.7 | | | |
| 179 | | Do | Pipe line, T. 20 S., R. 14 E. | | .9562 | 16.4 | | | |
| 180 | | Do | Well, sec 6, T. 20 S., R. 15 E. | | .9472 | 17.8 | | | |
| 181 | | Do | Well, sec. 31, T. 19 S., R. 15 E. | | .9415 | 18.7 | | | |
| 182 | | Do | Tank, sec. 28, T. 19 S., R. 15 E. | | .9247 | 21.4 | | | |
| 183 | | Do | Tank, sec. 20, T. 19 S., R. 15 E. | | .8568 | 33.4 | | | |
| 184 | | Do | Well, sec. 20, T. 19 S., R. 15 E. | | .800 | 45.0 | | | |
| 185 | | Alcade district | Well, sec. 20, T. 18 S., R. 13 E. | | .9091 | 24.0 | | | |
| 186 | | Vallecitos district | Spring | | .915 | 23.0 | | | |
| 187 | | Do | Well | | .975 | 13.6 | | | |
| 188 | | Oil City–Coalinga. | Tank average | | .8542 | 33.9 | | | |
| 189 | | Do | | | .800 | 45.0 | | | |
| 190 | | Do | | | .8584 | 33.1 | | | |
| 191 | | Twenty-eight Oil district | | | .9415 | 18.7 | | | |
| 192 | | Do | | | .9211 | 22.0 | Dark brown | | 65.5 C. |
| 193 | | Southwest district | | | .9472 | 17.8 | | | |

164. California State Min. Bur., Annual Rept., 1894, p. 352.
165. U. S. Geol. Survey, from card reporting production, 1905.
166. Mineral Resources U. S. for 1897.
167. California State Min. Bur., Bull. 3, p. 90.
168. Mineral Resources U. S. for 1896, Dr. Frederic Salathe, analyst.
172. Am. Chem. Jour., vol. 19, p. 802, Chas. F. Mabery.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 0 | ...... | [a]8.5 | ...... | 91.5 | ... | ...... | [a] Up to 320° C. | 164 |
| 0 | ...... | 14.5 | | 85.5 | | 9.5 | | 165 |
| 18-20 | ...... | 47-48 | | | .. | ...... | Heavy fuel oil, 10 to 13 p. ct. | 166 |
| 0 | ...... | [a]3.30 | 0.820 | 96.7 | | | [a] Up to 320° C. | 167 |
| [a]30.0 | ...... | [b]60.0 | ...... | 10.0 | | 10.0 | [a] 49°-141° C.; [b] 141°-275° C. Residuum hard asphalt. | 168 |
| 18.0 | ...... | [a]48.7 | ...... | 33.3 | | 16.2 | [a] 150°-350° C.; 350° C. to asphalt, 18 p. ct | 169 |
| .8 | ...... | [a]57.5 | ...... | 41.7 | | 25.4 | [a] 150°-350° C.; 350° C. to asphalt, 14.5 p. ct. | 170 |
| 1.1 | ...... | [a]62.4 | ...... | 30.5 | | 14.6 | [a] 150°-350° C.; 350° C. to asphalt, 21.50 p. ct | 171 |
| 33.06 | 0.7820 | 57.85 | .8508 | 9.09 | 0.21 | .. | Combustion gives carbon 86.24 p. ct.; hydrogen, 13.08 p. ct.; bromine absorption, 9.07 p. ct. | 172 |
| 5.7 | .7716 | 34.1 | .8582 | 60.2 | 45 | .. | Calorific value per c. c., 9,726. Viscosity by Redwood viscometer, 172 at 15° C., 37 at 85° C. | 173 |
| 24.2 | .7317 | 38.3 | .8473 | 37.5 | .38 | 9.1 | Calorific value per c. c., 9,321. Viscosity by Redwood viscometer, 56 at 15° C., 32.5 at 85° C. | 174 |
| ...... | ...... | 13.7 | .8588 | 86.3 | 78 | 31.8 | Viscosity by Redwood viscometer, 186 at 85° C.; calorific value per c. c., 10,088. | 175 |
| 36.1 | .7973 | 55.0 | .8760 | 8.9 | .06 | 4.1 | Calorific value per c. c., 9,040; viscosity by Redwood viscometer, 28.5 at 15° C., 2.55 at 85° C. | 176 |
| 0 | ...... | [a]0 | | | | 34.8 | [a] 150°-270° C.; above 270° C., 65.2 p. ct | 177 |
| 0 | ...... | [a]5.8 | .8504 | 94.2 | | 27.9 | [a] 150°-270° C.; above 270° C., 64.5 p. ct | 178 |
| 0 | ...... | [a]6.5 | .8563 | 93.5 | | 21.7 | [a] 150°-270° C.; above 270° C., 70 p. ct | 179 |
| 0 | ...... | [a]18.3 | .8495 | 81.7 | | 20.1 | [a] 150°-270° C.; above 270° C., 58.6 p. ct | 180 |
| 0 | ...... | [a]15.0 | .8573 | 85.0 | | 22.1 | [a] 150°-270° C.; above 270° C., 62.4 p. ct | 181 |
| 1.0 | ...... | [a]25.0 | .8353 | 74.0 | | 15.2 | [a] 150°-270° C.; above 270° C., 54 p. ct. | 182 |
| 28.0 | .7928 | [a]50.0 | .861 | 22.0 | | Tr. | [a] 150°-270° C.; above 270° C., 21 p. ct | 183 |
| 52.0 | .7701 | [a]27.0 | .806 | 21.0 | | | [a] 150°-270° C.; above 270° C., 18 p. ct. Asphalt none. | 184 |
| 1.0 | ...... | [a]33.0 | .8388 | 66.0 | | 6.0 | [a] 150°-270° C.; above 270° C., 57.9 p. ct. | 185 |
| 10.7 | .7568 | [a]31.0 | .8314 | 58.3 | | 21.3 | [a] 150°-270° C.; above 270° C., 35.9 p. ct. | 186 |
| ...... | ...... | [a]10.43 | .886 | 89.57 | | | [a] Up to 320° C. | 187 |
| 11.4 | .7521 | [a]35.8 | .813 | 52.8 | | | Residue liquid | 188 |
| 52.0 | ...... | 27.0 | ...... | 21.0 | | 0 | [a] 150°-270° C. | 189 |
| 28.0 | ...... | [a]50.0 | ...... | 22.0 | .062 | | [a] 150°-270° C.; above 270° C., 22 p. ct.; nitrogen, 0.063 p. ct. | 190 |
| 1.0 | ...... | [a]18.0 | ...... | 81.0 | | 20.0 | [a] 150°-270° C., above 270° C., 61 p. ct. Oil at 19° C., nitrogen, 0.314 p. ct. | 191 |
| 6.0 | ...... | [a]26.0 | ...... | 68.0 | .817 | 15.0 | [a] 150°-270° C.; above 270° C., 53 p. ct. Viscosity by Engler instrument, 30. Oil at 22° C., nitrogen, 0.302 p. ct. | 192 |
| 0 | ...... | [a]18.0 | ...... | 82.0 | .874 | 22.0 | [a] 150°-270° C.; above 270° C., 60 p. ct. Oil at 18° C., nitrogen, 0.299 p. ct. | 193 |

**173. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.**
**174-176. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.**
**177-186. California State Min. Bur., Bull. 31, P. W. Prutzman.**
**187. California State Min. Bur., Bull. 3, p. 90 (laboratory analysis).**
**188. California State Min. Bur., Bull. 31, p. 192.**
**189-193. Mineral Resources, U. S., for 1903, analysis by Paul W. Prutzman.**

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Fresno County—Con. | | | | | | | |
| 194 | | Southwest district | | | 0.9582 | 16.1 | Black | | 121° C. |
| 195 | | Fresno, San Benito | | | .9050 | 24.7 | | | |
| 196 | | Do | | | .8589 | 33.0 | | | |
| 197 | | Do | | | .915 | 23.0 | | | |
| 198 | | Humboldt County | | | .9518 | 17.1 | Yellow | 101° C. | |
| 199 | | Do | | | .8973 | 26.0 | do | 109° C. | |
| 200 | | Do | | | .9014 | 25.3 | do | 41° C. | |
| 201 | | Do | | | .881 | 28.9 | Red brown | | |
| 202 | | Do | | | .8263 | 39.4 | Yellow | Below 10° C. | |
| 203 | | Do | | | .7854 | 48.3 | | 17° C. | |
| 204 | | Mattole | | | .8163 | 41.5 | Bright green | | |
| | | Kern County: | | | | | | | |
| 205 | | Kern River | | | .962 | 15.5 | | 204.4° C. | |
| 206 | | Do | Tank average. | | .9622 | 15.5 | | | |
| 207 | | Do | Well, sec. 8, T. 29 S., R. 28 E. | | .9972 | 10.4 | | | |
| 208 | | Do | Well, sec. 3, T. 29 S., R. 28 E. | | .9722 | 14.0 | | | |
| 209 | | Do | Pipe line. | | .9642 | 15.2 | | | |
| 210 | | Do | Omar 4, Associated Oil Co. | 1,052 | .9609 | 15.7 | | Above 70° C. | |
| 211 | | Do | Well of King Refining Co. | 850 | .9792 | 13.0 | | Above 70° C. | |
| 212 | | Do | Tank average. | | .9655 | 15.0 | | | |
| 213 | | Do | | | .9782 | 13.1 | Black | | |
| 214 | | Do | | | .9673 | 14.7 | do | | |
| 215 | | Do | | | .9655 | 15.0 | | | |
| 216 | | Midway | | | .9321 | 20.2 | Black brown | 71° C | |
| 217 | | Do | Sec. 22, T. 32 N., R. 23 E. | | .9790 | 13.0 | | | |
| 218 | | Do | Sec. 17, T. 32 N., R. 23 E. | | .9517 | 17.1 | | | |
| 219 | | McKittrick | | | .9480 | 17.7 | Black | | |
| 220 | | Do | | | .9650 | 15.1 | do | | |
| 221 | | Do | | | .9396 | 19.0 | | | |
| 222 | | Do | | | .9655 | 15.0 | | | |
| 223 | | Do | Pipe line, sec. 13, T. 30 S., R. 21 E. | | .9655 | 15.0 | | | |
| 224 | | Do | Well, sec. 12, T. 30 S., R. 21 E. | | .9649 | 15.1 | | | |

194-197. Mineral Resources, U. S., for 1903, analysis by Paul W. Prutzman.
198-200. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill, Univ. California.
201-203. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill.
205, 207-209, 217, 218. California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.
206. California State Min. Bur., Bull. 19, Thos. Price & Son, analysts.
207. California State Min. Bur., Bull. 31, analyst not given.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | Residuum (cubic centimeters). | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
| 0 | ...... | [a]7.0 | ...... | 93.0 | ...... | 21.0 | [a] 150°-270° C.; above 270° C., 72 p. ct. Oil at 16° C., nitrogen, 0.375 p. ct. | 194 |
| 8.0 | ...... | [a]31.0 | ...... | 61.0 | ...... | 16.0 | [a] 150°-270° C.; above 270° C., 45 p. ct. | 195 |
| 20.0 | ...... | [a]25.0 | ...... | 55.0 | ...... | 5.0 | [a] 150°-270° C.; above 270° C., 50 p. ct. | 196 |
| 11.0 | ...... | [a]31.0 | ...... | 58.0 | ...... | 22.0 | [a] 150°-270° C.; above 270° C., 36 p. ct. | 197 |
| ...... | ...... | [a]16.10 | ...... | 83.90 | ...... | 26.5 | [a] 150°-270° C.; 250°-350° C., 53.60 p. ct. | 198 |
| ...... | ...... | [a]15.7 | ...... | 84.3 | ...... | 4.9 | [a] 150°-250° C.; 250°-350° C., 35.10 p. ct. Viscosity at 15.5° C., 3 (Engler method). | 199 |
| 13.7 | ...... | [a]33.40 | ...... | 52.9 | ...... | 19.4 | [a] 150°-250° C.; 250°-350° C., 22.20 p. ct. | 200 |
| ...... | ...... | [a]47.5 | ...... | 52.5 | ...... | 7.5 | [a] 150°-250° C.; 250°-350° C., 35.20 p. ct. Hydrogen, 12.03 p. ct.; carbon, 86.60 p. ct. Viscosity at 15.5° C., 1.57; at 85° C., 1.05 (Engler method). | 201 |
| 39.5 | ...... | [a]29.8 | ...... | 30.7 | ...... | 4.7 | [a] 150°-250° C.; 250°-350° C., 24 p. ct. Viscosity at 15.5° C., 1.1; at 85° C., 0.95 (Engler method). | 202 |
| 32.6 | ...... | [a]28.2 | ...... | 39.2 | ...... | 5.0 | [a] 150°-250° C.; 250°-350° C., 17.2 p. ct. Viscosity at 15.5° C., 1.17; at 85° C., 0.96 (Engler method). | 203 |
| 28.5 | 0.7447 | [a]42.0 | 0.7977 | 29.5 | ...... | ...... | [a] 150°-270° C.; above 270° C., 30 p. ct. Asphalt none. Maumene No. 0.03. | 204 |
| ...... | ...... | 10.9 | .874 | 89.1 | ...... | ...... | 300°-350° C., 10 p. ct.; sp. gr. 0.896 | 205 |
| ([a]) | ...... | ...... | ...... | ...... | ...... | 33.0 | Run without care to avoid cracking in steam still; products varied. [a] Temperature not given. | 206 |
| ...... | ...... | ...... | ...... | 100.0 | ...... | 31.9 | Above 270° C., 65.8 p. ct., sp. gr. 0.9241 | 207 |
| ...... | ...... | ...... | ...... | 100.0 | ...... | 35.2 | Above 270° C., 61.1 p. ct., sp. gr. 0.9144 | 208 |
| ...... | ...... | [a]13.0 | ...... | 87.0 | ...... | 16.2 | [a] 150°-270° C.; above 270° C., 67.5 p. ct., sp. gr. 0.9259. | 209 |
| 0 | ...... | 20.2 | .8626 | 79.8 | 0.94 | 21.4 | Caloric value per c. c., 9,989. 300° C. to asphalt, 56.5 p. ct. Viscosity at 85° C., 134; at 15.5° C., over 1,800 (Redwood viscometer used). | 210 |
| 0 | ...... | 22.5 | .8901 | 77.5 | ...... | 31.1 | 300° C. to asphalt, 44.4 p. ct. Viscosity at 85° C., 410; at 15° C., over 1,800 (Redwood viscometer used). | 211 |
| ([a]) | ...... | ...... | ...... | ...... | ...... | 38.7 | Still run in usual manner in making asphalt and distillate. [a] Temperature not given. | 212 |
| ...... | ...... | [a]37.9 | ...... | 62.1 | ...... | 31.6 | [a] 150°-350° C.; 350° C. to asphalt, 27.2 p. ct. B. t. u., 18,342. | 213 |
| 1.0 | ...... | [a]28.99 | ...... | 71.01 | .95 | 21.25 | [a] 150°-350° C.; 350° C. to asphalt, 48.13 p. ct. B. t. u., 10.471. Viscosity at 15.5° C., 274.35; at 85° C., 3.35. | 214 |
| ...... | ...... | [a]11.0 | ...... | 89.0 | .612 | 35.0 | [a] 150°-270° C.; above 270° C., 54 p. ct. Maumene No. 0.341. Oil at 15° C., nitrogen, 0.60 p. ct. | 215 |
| 3.0 | ...... | [a]24.0 | ...... | 73.0 | ...... | 20.0 | [a] 150°-270° C.; 270° C. to asphalt, 53 p. ct. Oil at 20° C., nitrogen, 3.74 p. ct. | 216 |
| 0 | ...... | [a]0 | ...... | 100.0 | ...... | 36.0 | Above 270° C., 61.2 p. ct., sp. gr. 0.9168. [a] 150°-270° C. | 217 |
| 0 | ...... | [a]5.7 | .8589 | 94.3 | ...... | 36.7 | [a] 150°-270° C.; 270° C. to asphalt, 54.2 p. ct. | 218 |
| 0 | ...... | [a]39.9 | ...... | 60.1 | .87 | 14.25 | [a] 150°-350° C.; 350° C. to asphalt, 45.82 p. ct. Hydrogen, 11.45 p. ct.; carbon, 86.06 p. ct. B. t. u., 18,675. | 219 |
| Tr. | ...... | [a]32.0 | ...... | 68.0 | .87 | 15.0 | [a] 150°-350° C.; 350° C. to asphalt, 53.25 p. ct. B. t. u., 18,570.6. | 220 |
| 1.0 | ...... | [a]22.0 | ...... | 77.0 | .87 | 21.0 | [a] 150°-270° C.; 270° C. to asphalt, 56 p. ct. Maumene No. 0.347. Oil at 19° C., nitrogen, 0.8 p. ct. | 221 |
| 0 | ...... | [a]11.0 | ...... | 89.0 | .565 | 26.0 | [a] 150°-270° C.; above 270° C., 63 p. ct. Maumene No. 0.365. Nitrogen, 0.29 p. ct. (according to Mabery and Hudson). (See Am. Chem. Jour., vol. 25, p. 253.) | 222 |
| ...... | ...... | [a]11.0 | .8568 | 89.0 | ...... | 26.9 | [a] 150°-270° C.; above 270° C., 59 p. ct. | 223 |
| ...... | ...... | [a]11.4 | .8464 | 88.6 | ...... | 28.9 | [a] 150°-270° C.; above 270° C., 57.4 p. ct. | 224 |

210-212. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
213, 214, 219, 220. Jour. Am. Chem. Soc., vol. 25, Edmond O'Neill, Univ. California.
215, 216. Mineral Resources U. S. for 1903, p. 177, Paul W. Prutzman, analyst.
221, 222. Mineral Resources U. S. for 1905, Paul W. Prutzman.
223, 224. California State Min. Bur. Bull. 31, Paul W. Prutzman, chemist.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Kern County—Cont'd. | | | | | | | |
| 225 | | McKittrick | Tank, sec. 20, T. 30 S., R. 22 E. | | 0.9402 | 18.9 | | | |
| 226 | | Do. | Well | | .9396 | 19.0 | | | |
| 227 | | Do. | Well 5, Southern Pacific Oil Co. | 500 | .9425 | 18.5 | | 32° C. | |
| 228 | | Do. | Shamrock 3, Associated Oil Co. | 1,377 | .9396 | 19.0 | | 35° C. | |
| 229 | | Do. | Well of Induna Oil Co. | 900 | .9747 | 13.6 | | Above 70° C. | |
| 230 | | Sunset | | | .9715 | 14.1 | | | |
| 231 | | Do. | | | Ab't 1,000 | 9.9 | | | |
| 232 | | Do. | No. 1, Western Minerals Co. | 500 | .9840 | 12.2 | | Above 70° C. | |
| 233 | | Do. | No. 1, Alameda Oil Co. | 790 | .9816 | 12.6 | | 44° C. | |
| 234 | | Do. | Pipe line | | .9722 | 14.0 | | | |
| 235 | | Do. | ..do | | .9504 | 17.3 | | | |
| 236 | | Do. | No. 2, group 2. | | .971 | 14.2 | | | |
| 237 | | Do. | | | .9655 | 15.0 | | | |
| 238 | | Do. | | | .9504 | 17.3 | | | |
| 239 | | Do. | | | 1.00 | 9.9 | | | |
| 240 | | Do. | | | .9603 | 15.8 | Black | | |
| 241 | | Do. | | | .9267 | 21.1 | ..do | | |
| 242 | | Do. | Shallow well | | .9784 | 13.1 | | | |
| | | Los Angeles County: | | | | | | | |
| 243 | | Little Moorn Canyon | No. 1 | | .910 | 23.9 | | | |
| 244 | | Not located | | | .9709 | 14.2 | | | |
| 245 | | Los Angeles City | Park street | | .9534 | 16.8 | | | |
| 246 | | Do. | ..do | | .9520 | 17.0 | | | |
| 247 | | Do. | ..do | | .9515 | 17.1 | | | |
| 248 | | Do. | ..do | | .9539 | 16.8 | | | |
| 249 | | Do. | ..do | | .9528 | 16.9 | | | |
| 250 | | Do. | ..do | | .9565 | 16.4 | | | |
| 251 | | Do. | ..do | | .9580 | 16.1 | | | |
| 252 | | West Los Angeles City. | McIntosh well | | .9816 | 12.6 | | | |
| 253 | | Do. | Maltman well | | .9702 | 14.3 | | | |
| 254 | | East End Field, Los Angeles City. | No. 2, Proudfitt & Parker. | 1,225 | .9699 | 14.4 | | Above 70° C. | |
| 255 | | Do. | No. 10, Davis & Harrison. | 1,275 | .9774 | 13.2 | | Above 70° C. | |

225, 226, 234, 235. California State Min. Bur., Bul. 31, Paul W. Prutzman, chemist.
227-233. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
236, 237. California State Min. Bur., Bull. 3 (laboratory analysis).
238, 239. Mineral Resources U. S. for 1903, Paul W. Prutzman, analyst.
240, 241. Jour. Am. Chem. Soc., vol. 25, Edmond O'Neill, University of California.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity | | | | | |
| 0.5 | ...... | [a]22.0 | 0.8403 | 77.5 | ...... | 22.6 | [a] 150°-270° C.; above 270° C., 53 p. ct....... ... .. | 225 |
| .5 | ..... | [a]22.0 | .8299 | 77.5 | ...... | 27.6 | [a] 150°-270° C.; above 270° C., 48.6 p. ct........... | 226 |
| 4.2 | 0.776 | 37.8 | .8675 | 58.0 | 0.77 | 22.5 | [a] 300° C. to asphalt, 35 p. ct. Viscosity by Redwood viscometer at 15° C., 1,100; at 85° C., 54. Calorific value per c. c., 9,804. | 227 |
| 4.0 | .779 | 35.1 | .8964 | 60.9 | .76 | 21.0 | 300° C. to asphalt, 40.1 p. ct. Viscosity by Redwood viscometer, at 15° C., 8,333; at 85° C., 50. Calorific value per c. c., 9,817. | 228 |
| ...... | ...... | 26.7 | .8830 | 73.3 | 1.08 | 23.0 | 300° C. to asphalt, 39.3 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 182. Calorific value per c. c., 10,092. 10 p. ct water in sample. | 229 |
| ([a]) | ...... | 12.7 | .8589 | 87.3 | .... | 29.3 | [a] Temperature not given. Precautions taken against cracking. | 230 |
| ([a]) | ...... | 2.9 | .8589 | 97.1 | ...... | .. | [a] Temperature not given. Sample probably the heaviest from any well in California. | 231 |
| ...... | ...... | 27.4 | .8974 | 72.6 | ...... | 28.8 | 300° C. to asphalt, 36.4 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 410. | 232 |
| ...... | ...... | 43.6 | .8789 | 56.4 | .90 | 23.5 | 300° C. to asphalt, 34.5 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 82.5. Calorific value per c. c., 10,173. | 233 |
| ...... | ...... | [a]12.0 | .8439 | 88.0 | ...... | 32.0 | [a] 150° 270° C., above 270° C., 53 p. ct.. ......... | 234 |
| 4.1 | ..... | [a]12.3 | .8107 | 83.6 | .. | 24.0 | [a] 150°-270° C.; above 270° C., 57.6 p. ct ..... | 235 |
| ..... | ... | [a]14.0 | .893 | 86.0 | ...... | .. | [a] Below 325° C.; below 250° C., 1 p. ct. ... .... | 236 |
| ..... | ..... | 14.2 | .8589 | 85.8 | .. | | 300°-350° C., 5.2 p. ct., sp. gr. 0.875. ............ | 237 |
| 4.0 | .. | [a]12.0 | | 84.0 | .86 | 24.0 | [a] 150° 270° C., above 270° C., 60 p. ct. Oil at 17° C., nitrogen, 0.476 p. ct. | 238 |
| ...... | .... | [a]5.0 | .... | 95.0 | 1.253 | 51.0 | [a] 150°-270° C., above 270° C., 44 p. ct. Maumene No. 0.432. Oil at 10° C., nitrogen, 0.370 p. ct. | 239 |
| ...... | ...... | [a]11.9 | | 88.1 | .86 | 23.9 | [a] 150°-250° C., 250°-350° C., 26.40 p. ct.; 350° C. to asphalt, 37.80 p. ct. Nitrogen, 0.047. B. t. u., 18,684. | 240 |
| 6.50 | | [a]17.26 | | 76.24 | | 11.0 | [a] 150°-250° C.; 250°-350° C., 17.25 p. ct.; 350° C. to asphalt, 47.98 p. ct. | 241 |
| [a]8.9 | .867 | [b]32.0 | .. | 59.1 | | | Distilled in vacuo 26 mm.; 60°-100° C., 0.9 p. ct. [a] 60°-145° C. [b] 145°-270° C., 190°-220° C., 8 p. ct., sp. gr. 0.9200; 220°-224° C., 8 p. ct., sp. gr. 0.9347, refractive index 1.523; 245°-270° C., 8 p. ct., sp. gr. 0.9621, refractive index 1.526. Other data showing results of treatment with 10 p. ct. solution NaOH and $H_2SO_4$. | 242 |
| 6.6 | .757 | 26.2 | .8141 | 67.2 | ...... | .. | 150°-200° C., 11.20 p. ct., sp. gr. 0.787; 200°-25° C., 7 p. ct., sp. gr. 0.821 | 243 |
| Tr. | ..... | 6.0 | .... | 94.0 | ..... | 25.0 | Pyridine base equals 3.2 p. ct........................ | 244 |
| Tr. | ...... | 21.6 | .8533 | 78.4 | | | 300°-350° C., 3 p. ct.......... | 245 |
| Tr. | ..... | 22.3 | .8650 | 77.7 | | | 300°-350° C., 7.1 p. ct., sp. gr. 0.889............ | 246 |
| Tr. | ...... | 23.2 | .8589 | 76.8 | | | 300°-350° C., 8 p. ct., sp. gr. 0.8895.. | 247 |
| Tr. | .... | 27.2 | .8589 | 72.8 | | | 300°-350° C., 5 p. ct., sp. gr. 0.8922.............. | 248 |
| Tr. | ...... | 20.0 | .8441 | 80.0 | | | 300°-350° C., 4 p. ct. | 249 |
| Tr. | ..... | 13.0 | .8662 | 87.0 | | | 300°-350° C., 3.4 p. ct....... | 250 |
| Tr. | ... | 13.4 | .8721 | 86.6 | | | 300°-350° C., 7 p. ct., sp. gr. 0.8820............. | 251 |
| Tr. | ...... | 1.6 | .. | 98.4 | | | 300°-350° C., 4.4 p. ct... | 252 |
| Tr. | ...... | 9.0 | .8680 | 91.0 | .. | | 300°-350° C., 9.6 p. ct.... | 253 |
| 0 | ...... | 17.9 | .8871 | 82.1 | .. | 28.8 | Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 51.1 p. ct. Gravities at 15° C. | 254 |
| 0 | ...... | 12.0 | .8912 | 88.0 | .49 | 19.8 | Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 36.3 p. ct. Gravities at 15° C. Calorific value per c. c., 9,863; water, 30 p. ct. | 255 |

242. Pet. Rev., Jan. 5, 1907, Clifford Richardson.
243. California State Min. Bur., 1887, Dr. W. D. Johnston, chemist.
244. California State Min. Bur., Bull. 11, Frederick Salathe.
245–253. California State Min. Bur., (laboratory analysis).
254, 255. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. Specific. | Gravity. Degrees Baumé. | Color. | Flash point. | Begins to distill at— |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Los Angeles County—Continued. | | | | | | | |
| 256 | | East End Field, Los Angeles City. | Solans well, Davis & Henderson. | 950 | 0.9467 | 17.9 | | Above 70° C. | |
| 257 | | Do | No. 22, Consolidated Crude Oil Co | 800 | .9815 | 12.6 | | Above 70° C. | |
| 258 | | Knob Hill, Los Angeles City. | Hubbell No. 2, Los Angeles Rwy. Co. | 1,250 | .9558 | 16.5 | | Above 70° C. | |
| 259 | | Middle Field, Los Angeles City. | No. 12, J. W. Shirley. | 1,340 | .9559 | 16.5 | | Above 70° C. | |
| 260 | | Do | No. 13, Park Crude Oil Co. | 1,060 | .9706 | 14.2 | | Above 70° C. | |
| 261 | | Do | No. 1, E. A. Clampitt. | 1,080 | .9736 | 13.8 | | Above 70° C. | |
| 262 | | West End Field, Los Angeles City. | No. 4, Salt Lake Oil Co. | 1,264 | .9487 | 17.6 | | Below 15° C. | |
| 263 | | Do | 14 Brea Rancho Oil and Asphalt Co. | 410 | 1.010 | | | Above 70° C. | |
| 264 | | Do | No. 7, Westlake Oil Co. | 370 | .9860 | 12.0 | | Above 70° C. | |
| 265 | | Los Angeles | | | .9756 | 13.5 | | | |
| 266 | | Do | | | .9649 | 15.1 | Greenish | | |
| 267 | | Do | | | .9609 | 15.7 | | | |
| 268 | | Newhall district | Tank, sec. 13, T. 3 N., R. 16 W. | | .9511 | 17.2 | | | |
| 269 | | Do | Well, sec. 4, T. 3 N., R. 15 W | | .8107 | 42.7 | | | |
| 270 | | Do | No. 3, Pearl Oil Co. | 662 | .9474 | 17.8 | | 35.5° C. | |
| 271 | | Do | Santa No. 2, Santa Ana Oil Co. | 1,000 | .9687 | 14.5 | | Above 70° C. | |
| 272 | | Do | No. 2, Pacific Coast Oil Co. | 1,000 | .9666 | 14.8 | | Above 70° C. | |
| 273 | | Do | No. 2, Santa Ana Oil Co. | 1,000 | .9879 | 11.7 | | Above 70° C. | |
| 274 | | Do | No. 6, Pacific Coast Oil Co. | 750 | .8758 | 29.9 | | Below 15° C. | |
| 275 | | Do | No. 4, Pacific Coast Oil Co. | 1,400 | .8967 | 26.1 | | Below 15° C. | |
| 276 | | Do | Pico Canyon | | .844 | 35.9 | Dark brown | | |
| 277 | | Do | | | .8088 | 43.1 | | | |
| 278 | | Do | | | .8107 | 42.7 | | | |
| 279 | | Do | Pico, No. 2 | | .865 | 31.9 | | | |

256-264. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
265. Mineral Resources U. S. for 1903, Paul W. Prutzman.
266-270. California State Min. Bur., Bull. 31, Paul W. Prutzman.
271-275. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°–300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 0 | ...... | 24.1 | 0.8776 | 75.9 | ...... | 17.3 | 300° C. to asphalt, 57.6 p. ct. Gravities at 15° C. Viscosity by Redwood viscometer over 1,700 at 15° C. | 256 |
| 0 | ...... | 12.3 | .8835 | 87.7 | ...... | 16.2 | Water, 44.6 p. ct. Gravities at 15° C. 300° C. to asphalt, 25.8 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C. | 257 |
| 0 | ...... | 25.5 | .8592 | 74.5 | ...... | 21.5 | Gravities at 15° C. 300° C. to asphalt, 51.6 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C. | 258 |
| 0 | ...... | 21.5 | .8770 | 78.5 | .85 | 21.8 | Gravities at 15° C. 300° C. to asphalt, 54.5 p. ct. Calorific value per c. c., 9,976. Viscosity by Redwood viscometer over 1,800 at 15° C. | 259 |
| 0 | ...... | 26.3 | .8852 | 73.7 | 1.18 | 25.3 | Gravities at 15° C. 300° C. to asphalt, 44.2 p. ct. Calorific value per c. c., 10,073. Viscosity by Redwood viscometer over 1,800 at 15° C. | 260 |
| 0 | ...... | 20.0 | .8805 | 80.0 | 1.30 | 28.8 | Gravities at 15° C. 300° C. to asphalt, 47.2 p. ct. Calorific value per c. c., 9,377. Viscosity by Redwood viscometer over 1,800 at 15° C. | 261 |
| 10.8 | 0.7542 | 32.2 | .8712 | 57.0 | ...... | 26.8 | Gravities at 15° C. 300° C. to asphalt, 29.7 p. ct., up to 100° C., 2.9 p. ct. Viscosity by Redwood viscometer 2,170 at 15° C. | 262 |
| ...... | ...... | 27.8 | .8851 | 72.2 | ...... | 42.2 | Gravities at 15° C. 300° C. to asphalt, 20.9 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C. | 263 |
| ...... | ...... | 18.6 | .9029 | 81.4 | ...... | 21.3 | Gravities at 15° C. Water in sample, 35.7 p. ct. 300° C. to asphalt, 22.4 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C. | 264 |
| ...... | ...... | 10.0 | ...... | 90.0 | 1.082 | 31.0 | 150°–270° C.; above 270° C., 59 p. ct. Nitrogen 0.648 p. ct. | 265 |
| ...... | ...... | 20.0 | .8739 | 80.0 | ...... | 13.3 | 150°–270° C.; above 270° C., 63.7 p. ct | 266 |
| ...... | ...... | 17.2 | .8739 | 82.8 | ...... | 25.7 | 150°–270° C.; above 270° C., 54.1 p. ct | 267 |
| ...... | ...... | 21.9 | .8388 | 78.1 | ...... | 25.9 | 150°–270° C.; above 270° C., 50.2 p. ct | 268 |
| 51.0 | .783 | 43.0 | .8333 | 6.0 | ...... | ...... | 150°–270° C.; above 270° C., 4 p. ct.; loss, 2 p. ct | 269 |
| 1.2 | .779 | 40.2 | .8723 | 58.6 | .49 | 22.7 | 300° C. to asphalt, 34.8 p. ct. Gravities at 15° C. Calorific value per c. c., 9,911. Viscosity by Redwood viscometer 1,355 at 15° C. | 270 |
| ...... | ...... | 23.7 | .8767 | 76.3 | .72 | 28.3 | Gravities at 15° C. 300° C. to asphalt, 43.3 p. ct. Water, 3.5 p. ct. Calorific value per c. c., 10.044. Viscosity by Redwood viscometer over 1,800 at 15° C. | 271 |
| ...... | ...... | 34.2 | .8816 | 65.8 | .62 | 22.6 | Gravities at 15° C. 300° C. to asphalt, 34.6 p. ct. Water, 6.1 p. ct. Calorific value per c. c., 10,042. Viscosity by Redwood viscometer over 1,800 at 15° C. | 272 |
| ...... | ...... | 29.6 | .8816 | 70.4 | .69 | 22.6 | Gravities at 15° C. 300° C. to asphalt, 43 p. ct. Water, 4.2 p. ct. Calorific value per c. c., 10,139. Viscosity by Redwood viscometer over 1,800 at 15° C. | 273 |
| 20.3 | .7686 | 34.1 | .8424 | 45.6 | | 10.9 | Gravities at 15° C. 300° C. to asphalt, 30.3 p. ct. Viscosity by Redwood viscometer 61 at 15° C. | 274 |
| 30.9 | .7595 | 37.9 | .8315 | 32.2 | .28 | 6.8 | Gravities at 15° C. 300° C. to asphalt, 23 p. ct. Calorific value per c. c., 9,322. Viscosity by Redwood viscometer 38.5 at 15° C. | 275 |
| 15.0 | ...... | 45.0 | ...... | 40.0 | | ...... | Lubricating oil, 32 p. ct | 276 |
| 12.5 | ...... | 78.47 | ...... | 9.03 | ...... | 5.3 | ...... | 277 |
| ...... | ...... | ...... | ...... | ...... | | | Below 150° C., 51 p. ct.; 150°–270° C., 43 p. ct.; above 270° C., 6 p. ct. | 278 |
| 10.6 | .781 | 48.1 | .8247 | 41.3 | | | Below 150° C., 10.6 p. ct.; sp. gr., 0.781. 150°–200° C., 20.6 p. ct.; sp. gr., 0.800. 200°–250° C., 16.2 p. ct.; sp. gr. 0.883. 250°–300° C., 11.30 p. ct.; sp. gr., 0.858. | 279 |

**276, 277. Jour. Soc. Chem. Indust., vol. 6, Sir Boverton Redwood.**
**278. Mineral Resources U. S. for 1903, Paul W. Prutzman.**
**279. 7th Ann. Rept. California State Min. Bur., W. D. Johnston, chemist.**

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Los Angeles County—Continued. | | | | | | | |
| 280 | | Newhall district | Pico Canyon, H. & S., No. 3. | | 0.846 | 35.5 | | | |
| 281 | | Do | Pico, No. 4 | | .825 | 39.7 | | | |
| 282 | | Do | Pico, No. 9 | | .836 | 37.5 | | | |
| 283 | | Do | Pico, No. 13 | | .832 | 38.3 | | | |
| 284 | | Do | San Fernando well. | | .830 | 38.7 | | | |
| 285 | | Do | Pacific Coast Oil Co. well, Pico Canyon. | | .8414 | 36.4 | Dark green | | Below 40° C. |
| 286 | | Puente district | | | | | | | |
| 287 | | Do | Tank for wells 3, 4, 5, 6. | | .822 | 40.3 | | | |
| 288 | | Do | Well No. 6, Puente Oil Co. | 1,425 | .8775 | 29.5 | | Below 15° C. | |
| 289 | | Do | | | .8893 | 27.4 | | | |
| 290 | | Do | | | .8929 | 26.8 | | | |
| 291 | | Do | | | .8929 | 26.8 | | | |
| 292 | | Do | | | .8799 | 29.1 | | | |
| 293 | | Do | | | .9193 | 22.3 | | | |
| 294 | | Do | | | .8861 | 28.0 | | | |
| 295 | | Sarcinesca Ranch | Well No. 5, Union Oil Co. | 1,500 | .9656 | 15.0 | | 67° C | |
| 296 | | Whittier Field | | | .9396 | 19.0 | | | |
| 297 | | Do | No. 1, Whittier-Fillmore Oil Co. | 2,300 | .9669 | 14.8 | | Above 70° C. | |
| 298 | | Do | Home Oil Co., sec. 22, T. 2 S. | 1,713 | .9291 | 20.7 | | 26° C. | |
| 299 | | Do | Central Oil Co., sec. 22, T. 2 S. | 1,856 | .9215 | 21.9 | | 17° C. | |
| 300 | | Do | Well, sec. 26, T. 2 S., R. 11 W. | | .9309 | 20.4 | | | |
| 301 | | Do | do | | .9272 | 21.0 | | | |
| 302 | | Do | do | | .9144 | 23.1 | | | |
| 303 | | Do | do | | .9138 | 23.2 | | | |
| | | Marin County: | | | | | | | |
| 304 | | Bolinas Bay | Well | | .9241 | 21.5 | | | |
| 305 | | Do | | | .9241 | 21.5 | | | |
| 306 | | Monterey County | | | .8929 | 26.8 | | | |
| 307 | | Do | | | | | | | |

280-284, 287. 7th Ann. Rept. California State Min. Bur., W. D. Johnston, chemist.
285. Am. Chem. Jour., vol. 15, p. 19, Felix Lengfield and Edmond O'Neill, University of California.
286. Mineral Resources U. S. for 1882, p. 650, Joseph D. Weeks.
288, 289, 295-297. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
290-292. California State Min. Bur., Bull. 31, Paul W. Prutzman.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 30.0 | 0.7484 | 35.8 | 0.8333 | 34.2 | ...... | ...... | Below 100° C., 11.20 p. ct.; sp. gr., 0.723. 100°-125° C., 9.30 p. ct.; sp. gr., 0.752. 125°-150° C., 9.5 p. ct.; sp. gr., 0.775. 150°-200° C., 13.60 p. ct.; sp. gr., 0.802. | 280 |
| 28.8 | .7347 | 35.6 | .8135 | 35.6 | ...... | ...... | Below 100° C., 9.10 p. ct.; sp. gr., 0.702. 100°-125° C., 10.4 p. ct.; sp. gr., 0.739. 125°-150° C., 9.3 p. ct.; sp. gr., 0.762. 150°-200° C., 13.4 p. ct.; sp. gr., 0.787. | 281 |
| 29.6 | .7355 | 33.2 | .8205 | 37.2 | ...... | ...... | Below 100° C., 13.1 p. ct.; sp. gr., 0.710. 100°-125° C., 6.5 p. ct.; sp. gr., 0.743. 125°-150° C., 10 p. ct.; sp. gr., 0.764. 150°-200° C., 13.6 p. ct.; sp. gr., 0.794. | 282 |
| 24.5 | .7352 | 36.2 | .8124 | 39.3 | ...... | ...... | Below 100° C., 9.7 p. ct.; sp. gr., 0.713. 100°-125° C., 8.8 p. ct.; sp. gr., 0.742. 125°-150° C., 6 p. ct.; sp. gr., 0.761. 150°-200° C., 12 p. ct.; sp. gr., 0.783. | 283 |
| 37.7 | .7436 | 30.7 | .8259 | 31.6 | ...... | ...... | Below 100° C., 17.3 p. ct.; sp. gr., 0.720. 100°-125° C., 11 p. ct.; sp. gr., 0.753. 125°-150° C., 9.4 p. ct.; sp. gr., 0.776. 150°-200° C., 13.3 p. ct.; sp. gr., 0.803. | 284 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Refractive index 1.481 at 14° C.; 18 liters distilled; collected every 10°; per cent distillate not given. | 285 |
| 15.0 | ...... | 26.0 | ...... | 59.0 | ...... | 18.0 | ...... | 286 |
| 27.0 | .7421 | 23.4 | .8360 | 49.6 | ...... | ...... | Below 100° C., 10.6 p. ct.; sp. gr., 0.717. 100°-125° C., 8.7 p. ct.; sp. gr., 0.747. 125°-150° C., 7.7 p. ct.; sp. gr., 0.771. 150°-200° C., 10.2 p. ct.; sp. gr., 0.803. | 287 |
| 23.4 | .7564 | 33.1 | .8442 | 43.5 | 0.36 | 13.1 | Gravities at 15° C. 100°-150° C., 8 p. ct. 300° C. to asphalt, 28.8 p. ct. Calorific value per c. c., 9,389. Viscosity by Redwood viscometer 66.5 at 15° C. | 288 |
| 10.2 | .7323 | 35.91 | .8019 | 53.89 | ...... | ...... | 150°-200° C., 13.47 p. ct.; sp. gr., 0.7656. 200°-250° C., 12.24 p. ct.; 250°-300° C., 10.2 p. ct.; sp. gr., 0.8413. | 289 |
| 10.5 | .740 | [a]28.0 | .8065 | 61.5 | ...... | 26.0 | [a]150°-270° C.; above 270° C., 33 p. ct. | 290 |
| 12.5 | .7415 | [a]29.0 | .8121 | 58.5 | ...... | 24.0 | [a]150°-270° C.; above 270° C., 33 p. ct. | 291 |
| 21.0 | .7439 | [a]24.0 | .8168 | 55.0 | ...... | 22.1 | [a]150°-270° C.; above 270° C., 30.9 p. ct. | 292 |
| Tr. | ...... | 36.0 | .7893 | 64.0 | ...... | ...... | 300°-350° C., 2.9 p. ct.; sp. gr., 0.8610. | 293 |
| 10.2 | .7323 | 35.9 | .8018 | 53.9 | ...... | ...... | 300°-350° C., 8.5 p. ct.; sp. gr., 0.8502. | 294 |
| ...... | ...... | 41.9 | .8752 | 58.1 | ...... | 28.4 | 300° C. to asphalt, 28.5 p. ct.; sp. gr., 0.891. 150°-200° C., 5.2 p. ct.; sp. gr., 0.8197. 200°-250° C., 11.6 p. ct.; sp. gr., 0.8648. 250°-300° C., 25.1 p. ct.; sp. gr., 0.8915. Viscosity by Engler viscometer over 1,800 at 15° C. | 295 |
| 5.0 | ...... | [a]20.0 | ...... | 75.0 | .70 | 37.0 | [a]150°-270° C.; above 270° C., 38 p. ct. Maumene No. 0.335. Nitrogen, 0.669; oil at 19° C. | 296 |
| ...... | ...... | 28.6 | .8834 | 71.4 | .93 | 28.5 | 250°-300° C., 19.5 p. ct.; 300° C. to asphalt, 41.4 p. ct. Calorific value per c. c., 10,064. Gravities at 15° C. Viscosity by Redwood viscometer over 1,800 at 15° C. | 297 |
| 4.2 | .7756 | 38.3 | .8704 | 57.5 | ...... | 15.7 | Gravities at 15° C. 300° C. to asphalt, 39.8 p. ct. Viscosity by Redwood viscometer 393 at 15° C. | 298 |
| 6.9 | .7760 | 32.7 | .8543 | 60.4 | | 20.6 | Gravities at 15° C. 300° C. to asphalt, 39.4 p. ct. Viscosity by Redwood viscometer 325 at 15° C. | 299 |
| 0 | ...... | [a]23.4 | .8328 | 76.6 | ...... | 27.3 | [a]150°-270° C.; above 270° C., 45.3 p. ct. | 300 |
| 2.1 | .7568 | [a]23.9 | .8328 | 74.0 | ...... | 21.4 | [a]150°-270° C.; above 270° C., 48.4 p. ct. | 301 |
| 5.2 | .7598 | [a]27.3 | .8314 | 67.5 | ...... | 20.2 | [a]150°-270° C.; above 270° C., 44.7 p. ct. | 302 |
| 4.7 | .7475 | [a]24.0 | .8269 | 71.3 | ...... | 19.7 | [a]150°-270° C.; above 270° C., 46.9 p. ct. | 303 |
| 4.0 | .7543 | [a]20.7 | .8088 | 75.3 | | 22.9 | [a]150°-270° C.; above 270° C., 50 p. ct. | 304 |
| 2.0 | ...... | [a]24.0 | ...... | 74.0 | ...... | 22.0 | [a]150°-270° C.; above 270° C., 52 p. ct. Maumene No. 0.370. | 305 |
| 0 | ...... | [a]2.0 | | 98.0 | | | [a]150°-270° C.; above 270° C., 98 p. ct. | 306 |
| 0 | ...... | 37.8 | .868 | 62.2 | | | 180°-200° C., 9.4 p. ct., sp. gr., 0.840; 200°-250° C., 18 p. ct., sp. gr., 0.867. | 307 |

**293, 294.** California State Min. Bur., Bull. 11 (laboratory analysis).
**296, 305, 306,** Mineral Resources U. S. for 1903, Paul W. Prutzman, analyst.
**300-304.** California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.
**307.** 7th Ann. Rept. California State Min. Bur., 1887, W. D. Johnston, chemist.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Napa County: | | | | | | | |
| 308 | | Berryessa Valley | | | 0.9642 | 15.2 | | | |
| 309 | | Do | | | .9642 | 15.2 | | | |
| 310 | | Do | | | .9677 | 14.7 | Dark brown | 135° C. | |
| 311 | | Do | | | .9625 | 15.5 | Brown | 131° C. | |
| | | Orange County: | | | | | | | |
| 312 | | Fullerton | Columbia Oil Producing Co., well. | 680 | .9378 | 19.3 | | Below 15° C. | |
| 313 | | Do | Santa Fe well, sec. 8, T. 3 S. | 2,404 | .9399 | 19.0 | | 44° C. | |
| 314 | | Do | Santa Fe 39, sec. 9, T. 3 S. | 1,705 | .8536 | 34.0 | | Below 15° C. | |
| 315 | | Do | No. 12, Brea Canyon Oil Co. | 1,515 | .9147 | 23.1 | | Below 15° C. | |
| 316 | | Do | In sec. 8, T. 3 S., R. 9 W. | | .9596 | 15.9 | | | |
| 317 | | Do | Tank, sec.8, T. 3 S., R. 9 W. | | .9315 | 21.3 | | | |
| 318 | | Do | Well, sec.8, T. 3 S., R. 9 W. | | .9302 | 20.5 | | | |
| 319 | | Do | Well, sec.1, T. 3 S., R. 10 W | | .9132 | 23.3 | | | |
| 320 | | Do | Well, sec. 9, T. 3 S., R. 9 W. | | .8621 | 32.4 | | | |
| 321 | | Do | do | | .860 | 32.8 | | | |
| 322 | | Do | do | | .8589 | 33.0 | | | |
| 323 | | Do | Well, sec. 9, T. 3 S., R. 9 W. | | .8568 | 33.4 | | | |
| 324 | | Do | do | | .8511 | 34.5 | | | |
| 325 | | Do | Santa Fe well. | | .9429 | 18.6 | Brown | 26° C. | 35° C. |
| | | San Mateo County: | | | | | | | |
| 326 | | (Not located) | | | .8163 | 41.5 | | | |
| 327 | | Do | | | .783 | 48.8 | | | |
| 328 | | Do | | | .9206 | 22.1 | Brown | 90° C. | |
| 329 | | Half Moon Bay | | | .8154 | 41.7 | Greenish | | |
| 330 | | Do | | | .783 | 48.8 | | | |
| 331 | | Purissima Canyon. | Lane well | | .855 | 33.7 | | | |
| 332 | | Do | Tunitas well | | .799 | 45.2 | | | |
| | | San Benito County: | | | | | | | |
| 333 | | Bitterwater district | Well, sec. 32, T. 18 S., R. 10 E. | | .8107 | 42.7 | Green | | |

308. California State Min. Bur., Bull. 19, Paul W. Prutzman, analyst.
309. Mineral Resources U. S. for 1903, Paul W. Prutzman, analyst.
310, 311. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill.
312-315. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
316-322. California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.
323, 324, 330, 333. California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| ...... | ...... | ...... | ...... | ...... | ...... | 3.66 | Temperature not given. Lubricating oil, 46 p. ct.; gas oil, 32 p. ct; residuum, 18 p. ct; asphalt in residue, 3.66 p. ct.; sulphur, none. | 308 |
| 0 | ...... | [a]15.0 | ...... | 85.0 | ...... | .. | [a]150°-270° C.; above 270° C., 78 p. ct.; residuum, 7 p. ct. Maumene No. 0.153. | 309 |
| 0 | ...... | [a]15.7 | ...... | 84.3 | ...... | 11.4 | [a]250°-350° C.; 350° C. to asphalt 72.6 p. ct. | 310 |
| 0 | ...... | [a]87.0 | ...... | 13.0 | ...... | 9.0 | [a]250°-350° C.; 350° C. to asphalt, 4.2 p. ct.; hydrogen, 11.13 p. ct.; carbon, 88.08 p. ct. Viscosity 10.35 at 15.5° C. (Engler method). | 311 |
| 8.1 | 0.7481 | 34.6 | 0.8638 | 57.3 | ...... | 25.8 | Gravities at 15° C. 300° C. to asphalt, 31.2 p. ct. Viscosity by Redwood viscometer 1,020 at 15° C. | 312 |
| 0 | ...... | 37.2 | .8544 | 62.8 | 1.09 | 23.1 | Gravities at 15° C. 300° C. to asphalt, 38.2 p. ct. Calorific value per c. c., 9,813. Viscosity by Redwood viscometer 1,790 at 15° C. | 313 |
| 28.2 | .7459 | 32.2 | .8381 | 39.6 | .41 | 11.0 | Gravities at 15° C. 300° C. to asphalt, 26 p. ct. Calorific value per c. c., 9,200. Viscosity by Redwood viscometer 45.5 at 15° C. | 314 |
| 18.1 | .7597 | 36.9 | .8663 | 45.5 | .94 | 13.3 | Gravities at 15° C. 300° C. to asphalt, 29.2 p. ct. Calorific value per c. c., 9,678. Viscosity by Redwood viscometer 264 at 15° C. | 315 |
| 1.0 | ..... | [a]14.0 | .8393 | 85.0 | | 42.0 | [a]150°-270° C.; above 270° C., 41 p. ct. | 316 |
| Tr. | ... | [a]23.0 | .8178 | 77.0 | .. | 32.1 | [a]150°-270° C.; above 270° C., 42.9 p. ct. | 317 |
| 3.4 | .7536 | [a]18.8 | .8269 | 78.8 | .. | 25.9 | [a]150°-270° C.; above 270° C., 47.6 p. ct. | 318 |
| 10.5 | .7487 | [a]25.5 | .8240 | 64.0 | | 31.6 | [a]150°-270° C.; above 270° C., 31.4 p. ct. | 319 |
| 21.7 | .7403 | [a]25.8 | .8163 | 53.5 | | 9.0 | [a]150°-270° C.; above 270° C., 41.8 p. ct. | 320 |
| 23.8 | .7384 | [a]27.7 | .8202 | 49.5 | | 16.7 | [a]150°-270° C.; above 270° C., 31.2 p. ct. | 321 |
| 24.8 | .7334 | [a]27.6 | .8102 | 47.6 | .. | 15.6 | [a]150°-270° C.; above 270° C., 31.4 p. ct. | 322 |
| 22.1 | .7334 | [a]30.8 | .8173 | 47.1 | | 8.0 | [a]150°-270° C.; above 270° C., 37.6 p. ct. | 323 |
| 22.9 | .7288 | [a]27.9 | .8092 | 49.2 | ..... | 12.9 | [a]130°-270° C.; above 270° C., 33.4 p. ct. | 324 |
| 2.4 | .788 | [a]8.2 | .8319 | 89.4 | ...... | ...... | [a]135°-175° C., color of distillate pink, refractive index 1.435. Distillation under 25 mm. pressure, as follows: 40°-100° C., 4.2 p. ct.; sp. gr. 0.8745, refractive index 1.455, 100°-150° C., 10.4 p. ct.; sp. gr., 0.9195, refractive index 1.478; 150°-165° C., 7 p. ct.; sp. gr., 0.9547; refractive index, 1.496. Begins to crack; residue, 66.4 p. ct. | 325 |
| 39.0 | ...... | [a]46.0 | ...... | 15.0 | ...... | ...... | [a]130°-270° C.; above 270° C., 15 p. ct. | 326 |
| 48.0 | ...... | [a]33.0 | ...... | ...... | ...... | ...... | [a]150°-270° C.; above 270° C., 19 p. ct. | 327 |
| ...... | ...... | ...... | ...... | 100.0 | ...... | 26.0 | Water, 14.80 p. ct., 350° C. to asphalt, 58.9 p. ct. Viscosity, 10.96 at 15.5° C. (Engler method). | 328 |
| 47.0 | .7414 | 34.7 | .8254 | 18.3 | ...... | ...... | Temperature not given. Gasoline, 8.6 p. ct.; benzine, 12.9 p. ct.; engine distillate, 25.5 p. ct.; kerosene, 23.6 p. ct., stove oil, 11.1 p. ct.; lubricants, 8 p. ct. | 329 |
| 47.5 | .728 | [a]33.0 | .800 | 19.5 | ...... | ...... | [a]130°-270° C.; above 270° C., 16 p. ct. | 330 |
| 18.0 | .759 | 44.0 | .817 | 38.0 | ...... | ...... | ...... | 331 |
| 46.7 | .7414 | 35.0 | .820 | 18.3 | ...... | ...... | Below 100° C., 9.9 p. ct.; 100°-125° C., 17.3 p. ct.; 125°-150° C., 19.5 p. ct., 150°-200° C., 17.2 p. ct.; 200°-250° C., 11.8 p. ct.; 250°-300° C., 6 p. ct. | 332 |
| 31.0 | .7341 | [a]37.6 | .814 | 31.4 | ...... | ...... | [a]150°-270° C., above 270° C., 25.7 p. ct.; sp. gr., 0.8772; residue, 4.3 p. ct., not asphalt, though it contains that substance. | 333 |

325. Jour. Soc. Chem. Indust., No. 19, Clifford Richardson.
326, 327. Mineral Resources, U. S., for 1903, Paul W. Prutzman.
328. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill.
329. California State Min. Bur., Bull. 31.
331, 332. 7th Ann. Rept. Cal. State Min. Bur., W. D. Johnston, chemist.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Gravity. |  | Color. | Flash point. | Begins to distill at— |
|  |  |  |  |  | Specific. | Degrees Baumé. |  |  |  |
|  |  | CALIFORNIA—continued. |  |  |  |  |  |  |  |
|  |  | San Benito County—Continued. |  |  |  |  |  |  |  |
| 334 |  | Bitterwater district | Well, Nonpareil Petroleum Co. |  | 0.8107 | 42.7 | Green |  |  |
| 335 |  | Do |  |  | .8107 | 42.7 |  |  |  |
| 336 |  | Santa Cruz County |  |  | .9587 | 16.0 | Black |  |  |
|  |  | Santa Clara County: |  |  |  |  |  |  |  |
| 337 |  | (Not located) |  |  | .8537 | 34.0 | Light brown | 89.5° C. |  |
| 338 |  | Sargent | No. 2 well. Watsonville Oil Co. | 1,187 | .9416 | 18.7 |  | Below 15° C |  |
| 339 |  | Do | Tank |  | .9569 | 16.3 |  |  |  |
| 340 |  | Do | do. |  | .9511 | 17.2 |  |  |  |
| 341 |  | Do | Well |  | .9421 | 18.6 |  |  |  |
| 342 |  | Moodys Gulch | Well, Golden Gate Petroleum Co. |  | .8333 | 38.0 |  |  |  |
| 343 |  | Do | Well No. 4 |  | .812 | 42.4 |  |  |  |
| 344 | 309 | Do |  |  | .8333 | 38.0 |  |  |  |
|  |  | Santa Barbara County: |  |  |  |  |  |  |  |
| 345 |  | Lompoc | Hill No. 1, Union Oil Co. | 2,500 | .9574 | 16.2 |  | 21° C. |  |
| 346 |  | Summerland | Well, Sea Cliff Oil Co. |  | .9665 | 14.9 |  | Above 70° C. |  |
| 347 |  | Do | No. 4, Potomac Oil Co. | 260 | .9603 | 15.8 |  | Above 70° C. |  |
| 348 |  | Do | Tank sample. |  | .9655 | 15.0 |  |  |  |
| 349 |  | Do | Tank |  | .9722 | 14.0 |  |  |  |
| 350 |  | Do |  |  | .9858 | 12.0 | Black |  |  |
| 351 |  | Do |  |  |  |  |  |  |  |
| 352 |  | Do | Submarine well. |  | .9521 | 17.0 |  |  |  |
| 353 |  | Do |  |  | .9655 | 15.0 |  |  |  |

334. California State Min. Bur., Bull. 31 (name of analyst not given).
335, 344, 353. Mineral Resources U. S. for 1903, Paul W. Prutzman.
336, 337. Jour. Am. Chem. Soc., vol. 25, Edmond O'Neill.
338. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
339-342, 348. California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.
343. 7th Ann. Rept. Cal. State Min. Bur., W. D. Johnston, chemist.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 30.0 | ...... | 50.0 | ...... | 20.0 | ...... | ...... | Temperature not given. Gasoline, 10 p. ct.; sp. gr., 0.7071; engine distillate, 20 p. ct.; sp. gr., 0.7547; kerosene, 35 p. ct.; sp. gr., 0.8046; stove oil, 15 p. ct., sp. gr. 0.8485; lubricants, 19.7 p. ct., sp. gr. 0.9352. | 334 |
| 28.0 | ...... | [a]37.0 | ...... | 35.0 | ...... | ...... | [a]150°-270° C.; above 270° C., 35 p. ct. Maumene No. 0.068. | 335 |
| 0 | ...... | [a]6.2 | ...... | 93.8 | ...... | 22.8 | [a]150°-250° C.; 250°-350° C., 34 p. ct.; 350° C. to asphalt, 14.4 p. ct.; water, 21.5 p. ct. | 336 |
| 15.0 | ...... | [a]35.8 | ...... | 49.2 | 0.92 | 3.6 | [a]150°-250° C.; 250°-350° C., 31.2 p. ct.; 350° C. to asphalt, 14.4 p. ct. B. t. u. 20,145.6. Hydrogen, 12.88 p. ct., carbon, 86.08 p. ct. | 337 |
| 9.0 | 0.7050 | 41.4 | 0.8848 | 49.6 | .83 | 19.6 | Gravities at 15° C. Up to 100° C., 2 p. ct.; 100°-150° C., 7 p. ct.; 300° C. to asphalt, 27.2 p. ct. Calorific value per c. c., 9,786. Viscosity by Redwood viscometer, 750 at 15° C. | 338 |
| .8 | ...... | [a]20.0 | .8353 | 79.2 | ...... | 24.2 | [a]150°-270° C.; above 270° C., 50 p. ct. | 339 |
| 1.0 | ...... | [a]18.0 | .8419 | 81.0 | ...... | 27.0 | [a]150°-270° C.; above 270° C., 52 p. ct. | 340 |
| 6.0 | .7568 | [a]19.5 | .8434 | 74.5 | ...... | 37.0 | [a]150°-270° C.; above 270° C., 35.5 p. ct. | 341 |
| 25.0 | .7527 | 38.1 | .8046 | 36.9 | ...... | ...... | No temperature given. Engine distillate, 25 p. ct.; sp. gr. 0.7527; kerosene, 38.1 p. ct.; gas oil, 33.9 p. ct.; sp. gr., 0.8642; paraffin, 0.3 p. ct. | 342 |
| 33.8 | .7449 | 35.5 | .8201 | 30.7 | ...... | ...... | Below 100° C., 9.4 p. ct.; 100°-150° C., 24.4 p. ct.; sp. gr., 0.756; 150°-200° C., 17.1 p. ct.; sp. gr., 0.798; 200°-250° C., 14.8 p. ct.; sp. gr., 0.836. | 343 |
| 26.0 | ...... | [a]35.0 | ...... | 29.0 | ...... | 0 | [a]150°-270° C.; above 270° C., 39 p. ct. | 344 |
| 5.2 | ...... | 31.5 | .8417 | 63.3 | 4.43 | 20.6 | Gravities at 15° C. Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 34.3 p. ct. Calorific value per c. c., 9,822. Water, 7 p. ct. | 345 |
| 0 | ...... | 28.4 | ...... | 71.6 | .44 | 23.5 | Gravities at 15° C. 300° C. to asphalt, 45.5 p. ct. Calorific value per c. c., 10,001. Viscosity by Redwood viscometer over 1,800 at 15° C. | 346 |
| 0 | ...... | 28.3 | .8693 | 71.7 | ...... | 22.8 | Gravities at 15° C. 300° C. to asphalt, 48 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C | 347 |
| 0 | ...... | [a]10.0 | .8464 | 90.0 | ...... | 32.2 | [a]150°-270° C.; above 270° C., 54 p. ct. | 348 |
| .1 | ...... | 7.0 | ...... | 92.9 | ...... | 37.1 | Temperature not given. Gas oil, 16.3 p. ct., sp. gr. 0.8861; sp. gr. of kerosene, 0.8187; stove oil, 4 p. ct., sp. gr. 0.8589. | 349 |
| 0 | ...... | [a]6.5 | ...... | 93.5 | ...... | 22.5 | [a]150°-250° C.; 250°-530° C. 17.10 p. ct.; 350° C. to asphalt, 27.5 p. ct. Water, 25 p. ct. Viscosity 1,462 at 15.5° C. (Engler method). | 350 |
| ...... | ...... | ...... | ...... | ...... | ...... | 45.0 | Distilled in vacuo of 26 mm. pressure gave 55 p. ct. of distillate, collected in 15 portions; sp. gr. of fractions as follows: 0.8712, 0.8833, 0.8893, 0.9034, 0.9155, 0.9336, 0.9417, 0.9477, 0.9618, 0.9678, 0.9738, 0.9802, 0.9830, 0.990, 0.9939. | 351 |
| ...... | ...... | ...... | ...... | ...... | .84 | ...... | Nitrogen, 1.25 p. ct., carbon, 86.32 p. ct.; hydrogen, 11.7 p. ct. Distilled under pressure of 60 mm. Only small quantities passed over below 175° C.; residue of 10 p. ct. remained at 365° C. Following hydrocarbons isolated: At 20° C., $C_{13}H_{24}$; 150°-155° C., sp. gr. 0.8621, $C_{16}H_{30}$; 175°-180° C., sp. gr. 0.8808, $C_{17}H_{30}$; 190°-195° C., sp. gr. 0.8919, $C_{18}H_{32}$; 210°-215° C., sp. gr. 0.8990, $C_{24}H_{44}$; 250°-255° C., sp. gr. 0.9259, $C_{27}H_{46}$; 310°-315° C., sp. gr. 0.9451, $C_{29}H_{50}$; 340°-345° C., sp. gr. 0.9778. | 352 |
| 0 | ...... | [a]11.0 | ...... | 89.0 | .898 | 40.0 | [a]150°-270° C.; above 270° C. 49 p. ct. Nitrogen, 0.88, oil at 15° C. | 353 |

**345–347. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.**
**349. California State Min. Bur., Bull. 31 (analyst not given).**
**350. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill.**
**351. Pet. Rev., Dec. 8, 1906. Clifford Richardson.**
**352. Am. Acad. Arts and Sci., vol. 40, p. 340, C. F. Mabery and E. V. Zoni; also Jour. Franklin Inst. vol. 162, January, 1906.**

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Santa Barbara County—Continued. | | | | | | | |
| 354 | | Summerland | | | 0.9672 | 14.8 | | | |
| 355 | | Do. | | | .9513 | 17.2 | | | |
| 356 | | Do. | | | .9657 | 15.0 | | | |
| 357 | | Do. | | | .9672 | 14.8 | | | |
| 358 | | Do. | | | .9692 | 14.5 | | | |
| 359 | | Carreaga field | | | .9530 | 16.9 | Black | | |
| 360 | | Do. | Western Union Oil Co. well. | | .9303 | 20.5 | | Below 15° C. | |
| 361 | | Do. | do. | 2,776 | .8508 | 34.6 | | 15° C. | |
| 362 | | Near Casmalia field. | Well 3, Western Union Oil Co. | 1,610 | .9337 | 19.9 | | Below 15° C. | |
| 363 | | Santa Maria field | Wells 1 and 3, Pinal Oil Co. | 1,600 | .8882 | 27.6 | | Below 15° C. | |
| 364 | | Do. | | | .9530 | 16.9 | | | |
| 365 | | Do. | Pinal Oil Co. | | | | | | |
| 366 | | (Not located) | | | .980 | 12.8 | Dark, almost black. | | |
| 367 | | Do. | Tunnel of Hayward Petroleum Co. | | .9023 | 25.2 | | | |
| 368 | | Do. | Pico Spring | | .8932 | 26.7 | | | |
| 369 | | Do. | Canada Loga | | .9184 | 22.4 | | | |
| 370 | | Do. | Spring | | .9780 | 13.2 | | | |
| 371 | | Ojai Valley | | | .9175 | 22.6 | | | |
| 372 | | Ventura County | | | | | | | |
| 373 | | Do. | | | .8997 | 25.6 | | | |

354-358. California State Min. Bur., Bull. 11 (laboratory analysis).
359, 373. Mineral Resources U. S. for 1903, Paul W. Prutzman.
360-363. California State Min. Bur., Bull 31, H. N. Cooper, chemist.
364. From 1905 statistical card giving production of well owner.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). To 150° C. Cubic centimeters. | Distillation by Engler's method (by volume). To 150° C. Specific gravity. | Distillation by Engler's method (by volume). 150°-300° C. Cubic centimeters. | Distillation by Engler's method (by volume). 150°-300° C. Specific gravity. | Residuum (cubic centimeters). | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| 0 | ...... | 11.0 | 0.8452 | 89.0 | ...... | ...... | 300°-350° C., 5 p. ct., sp. gr. 0.8722 | 354 |
| Tr. | ...... | 21.4 | ...... | 78.6 | ...... | ...... | 300°-350° C., 12 p. ct., sp. gr. 0.8962 | 355 |
| Tr. | ...... | 11.6 | .8468 | 88.4 | ...... | ...... | 300°-350° C., 6.8 p. ct., sp. gr. 0.8900 | 356 |
| Tr. | ...... | 6.0 | ...... | 94.0 | ...... | ...... | 300°-350° C., 5 p. ct | 357 |
| Tr | ...... | Tr. | ...... | 100.0 | ...... | ...... | 300°-350° C., 4.6 p. ct | 358 |
| 1.0 | ...... | [a]24.0 | ...... | 75.0 | ...... | 38.0 | [a]150°-270° C.; above 270°., 38 p. ct. Maumene No. 4.82. Nitrogen, 0.43, oil at 17° C. Viscosity by Redwood viscometer 790 at 15° C. | 359 |
| 12.00 | 0.7481 | 43.2 | .8677 | 44.8 | ...... | 17.9 | Gravities at 15° C. 300° C. to asphalt, 27.4 p. ct.; 150°-200° C., 10.4 p. ct.; 200°-250° C., 8.3 p. ct. | 360 |
| 24.6 | .7508 | 36.2 | .8312 | 39.2 | 0.60 | 8.0 | Gravities at 15° C. 300° C. to asphalt, 30.4 p. ct. Calorific value per c. c., 9.203. Viscosity by Redwood viscometer 47.4 at 15° C. | 361 |
| 6.9 | .7596 | 30.8 | .8608 | 62.3 | 2.08 | 22.0 | Gravities at 15° C. 300° C. to asphalt, 39.5 p. ct. Calorific value per c. c., 9.907. Viscosity by Redwood viscometer 1,060 at 15° C. | 362 |
| 25.9 | .7460 | 30.6 | .8460 | 44.5 | 1.56 | 12.0 | Gravities at 15° C. 300° C. to asphalt, 29.7 p. ct. Calorific value per c. c., 9,364. Viscosity by Redwood viscometer 90 at 15° C. | 363 |
| 1.0 | ...... | [a]24.0 | .8299 | 75.0 | ...... | 41.9 | [a]150°-270° C., above 270° C., 31.1 p. ct | 364 |
| 12.0 | ...... | 12.0 | ...... | 76.0 | ...... | 16.0 | No temperature given. Gas oil, 10 p. ct.; lubricating oil, 50 p. ct. | 365 |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | Distillation to dryness produced 69.82 p. ct., sp. gr. 0.890 to 0.900; coke, water, and loss 30.18 p. ct. Oil of 0.885 sp. gr., 50 p. ct.; oil of 0.908 sp. gr., 17.5 p. ct. First distillate treated by cracking yielded a product having a density of about 0.885 at 60° F., or only 1° Baumé lower than before distillation. After treatment with sulphuric acid and soda and redistilling from soda it had a density of 0.880. | 366 |
| ...... | ...... | 15.0 | .810 | 85.0 | ...... | ...... | 40 to 50 p. ct. of middlings and 20 p. ct. light lubricating oil. Under pressure distillation 42 p. ct., sp. gr. 0.810; second pressure distillation of residue (49 p. ct.) yielded 44.15 p. ct.; second fractionation of sp. gr. 0.810, 12.25 p. ct. Total crude illuminating oil, 54.25 p. ct.; lubricating oil, 31.85 p. ct. | 367 |
| ...... | ...... | 20.0 | ...... | 80.0 | ...... | ...... | Under pressure distillation yielded 56.72 p. ct., sp. gr. 0.810; second pressure distillation of residue (30.94 p. ct.) yielded 28.74 p. ct., second fractionation of sp. gr. 0.810, 6.96 p. ct. Total crude illuminating oil, 62.68 p. ct.; lubricating oil, 20.88 p. ct. | 368 |
| ...... | ...... | 3.0 | ...... | 97.0 | ...... | ...... | Under pressure distillation yielded 40.33 p. ct., sp. gr. 0.810; second pressure distillation of residue (42.33 p. ct.) yielded 38.09 p. ct.; second fractionation of sp. gr. 0.810, 9.52 p. ct. Total crude illuminating oil, 49.85 p. ct., lubricating oil, 25.87 p. ct. | 369 |
| ...... | ...... | 2.5 | ...... | 97.5 | ...... | ...... | Sample from same spring as No. 366. Under pressure distillation yielded 16.7 p. ct., sp. gr. 0.810; second pressure distillation of residue (55.3 p. ct., water 12.5 p. ct.) yielded 49.8 p. ct.; second fractionation of sp. gr. 0.810, 12.4 p. ct. Total crude illuminating oil, 29.1 p. ct.; lubricating oil, 37.1 p. ct. | 370 |
| 23.4 | .7914 | [a]31.8 | ...... | 43.8 | ...... | ...... | [a]150°-274° C.; 30°-80° C., 7.8 p. ct., sp. gr. 0.768; 80°-118° C., 7.8 p. ct., sp. gr. 0.7728; 118°-150° C., 7.8 p. ct., sp. gr. 0.8334. | 371 |
| ...... | ...... | ...... | ...... | ...... | .40 | ...... | Carbon, 84 p. ct.; hydrogen, 12.7 p. ct.; nitrogen, 1.7 p. ct.; oxygen, 1.2 p. ct. | 372 |
| 10.0 | ...... | [a]24.0 | ...... | 66.0 | 1.5 | 22.0 | [a]150°-270° C.; above 270° C. 44 p. ct.; nitrogen, 0.606. | 373 |

365, 366. Am. Jour. Sci., 2d ser., vol. 43, p. 242, B. Silliman.
367-370. Am. Jour. Sci., 2d Ser., vol. 47, p. 10, S. F. Peckham.
371. Pet. Rev., Dec. 27, 1906, Clifford Richardson.
372. Mineral Resources U. S. for 1896; from Bull. 11, California State Min. Bur.

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| 374 | | Ventura County | Mixed crude | | 0.9091 | 24.0 | | | |
| 375 | | Do. | Pipe line average. | | .8974 | 26.0 | | | |
| 376 | | Do. | do. | | .9021 | 25.2 | | | |
| 377 | | Do. | | | .983 | 12.4 | | | |
| 378 | | Do. | | | .9159 | 22.9 | Brown | | |
| 379 | | Do. | | | .9165 | 22.8 | do. | | |
| 380 | | Do. | | | .8918 | 27.0 | Brown, thick | | 60° C. |
| 381 | | Adams Canyon | Green well | | .853 | 34.1 | | | |
| 382 | | Do. | Wild Bill well | | .915 | 23.0 | | | |
| 383 | | Do. | | | .9091 | 24.0 | Greenish | | |
| 384 | | Do. | No. 27, Union Oil Co. of California. | 2,745 | .8814 | 28.8 | | Below 15° C. | |
| 385 | | Do. | Green Oil tunnel, Union Oil Co. | | .9326 | 20.1 | | 68° C. | |
| 386 | | Buckhorn district | Well 15, Buckhorn Oil and Trans. Co. | 950 | .9685 | 14.6 | | Above 70° C. | |
| 387 | | Bardsdale Canyon | Robinson No. 2, Union Oil Co. | | .8881 | 27.7 | | Below 15° C. | |
| 388 | | Do. | Sec 12, T. 3 N., R. 20 W. | | .8861 | 28.0 | | | |
| 389 | | Do. | | | .8905 | 27.2 | Deep brown-black. | | |
| 390 | | Sespe district | | | .9402 | 18.9 | | | |
| 391 | | Four Forks | | | .9196 | 22.2 | | | |

374. California State Min. Bur., Bull. 1, p. 78, M. L. Watts.
375, 376. California State Min. Bur., Bull. 31, p. 193.
377-379. Jour. Am. Chem. Soc., vol. 25, p. 669, Edmond O'Neill.
380. Am. Chem. Jour., vol. 19, p. 797, Chas. F. Mabery.
381, 382. 7th Ann. Rept. California State Min. Bur., 1887, W. D. Johnston, chemist.

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| 7.0 | ...... | 23.0 | ...... | 70.0 | ...... | 11.0 | Average yield from 100 barrels determined by running: Gasoline, sp. gr. 0.6796, 3 barrels; benzine, sp. gr. 0.7254, 4 barrels; kerosene, sp. gr. 0.800, 15 barrels; kerosene, sp. gr. 38°-40° B., 8 barrels; gas distillate, sp. gr. 0.8861, 21 barrels; spindle oil, sp. gr. 0.8974, 10 barrels; neutral oil, sp. gr. 0.915, 12 barrels; heavy neutral oil. sp. gr. 0.9272, 6 barrels; lubricating oil, sp. gr. 0.9722, 5 barrels. | 374 |
| 10.4 | .7254 | 28.0 | .8116 | 61.6 | ...... | 23.7 | Gas oil, 16.1 p. ct., sp. gr. 0.8861; lubricating oil, 20.3, sp. gr. 0.915. | 375 |
| 14.5 | .7568 | 13.8 | .8140 | 71.7 | ...... | 14.9 | Stove oil, 14.4 p. ct., sp. gr. 0.8589; fuel distillate, 22.8 p. ct., sp. gr. 0.8974; lubricant, 16 p. ct., sp. gr. 0.9272. | 376 |
| 0 | ...... | [a]11.2 | ...... | 88.8 | ...... | 36.5 | [a]150°-250° C.; 250°-350° C., 34.05 p. ct.; 350° C. to asphalt, 8.75 p. ct. Water, 9.5 p. ct. | 377 |
| 12.0 | ...... | [a]16.0 | ...... | 72.0 | ...... | 13.8 | [a]150°-250° C.; 250°-350° C., 54.5 p. ct.; 350° C. to asphalt, 2.2 p. ct. | 378 |
| 17.0 | ...... | [a]11.5 | ...... | 71.5 | ...... | 41.0 | [a]150°-250° C.; 250°-350° C., 9 p. ct.; 350° C. to asphalt, 21.5 p. ct. | 379 |
| 9.7 | .7395 | 29.1 | ...... | 61.2 | 0.84 | ...... | Gravities at 20° C. Bromine absorption, 17.72. Percentage of nitrogen compound, 0.53 p. ct.; carbon, 85.60 p. ct.; hydrogen, 12.84 p. ct. Residue above 300° C. thick, nearly solid tar. (Vacuum distillation also given.) | 380 |
| 16.8 | .7518 | 42.4 | .8231 | 41.8 | ...... | ...... | 100°-125° C., 7.8 p. ct.; 150°-200° C., 18 p. ct.; 200°-250° C., 14.4 p. ct. | 381 |
| 9.2 | .732 | 26.5 | .8424 | 64.3 | ...... | ...... | 150°-200° C., 10.8 p. ct., sp. gr. 0.813; 200°-250° C., 8 p. ct., sp. gr. 0.846. | 382 |
| 5.2 | ...... | 24.5 | ..... | 70.3 | ...... | 7.0 | Temperature not given. Gas distillate, 17.3 p. ct.; lubricating oil, 46 p. ct. Pyridine base equals 0.88 p. ct. | 383 |
| 18.1 | .7717 | 28.5 | .8356 | 53.4 | .48 | 9.8 | Gravities at 15° C. 300° C. to asphalt, 43 p. ct. Calorific value per c. c., 9,384. Viscosity by Redwood viscometer 162.5 at 15° C. | 384 |
| .8 | ...... | 41.5 | .8461 | 58.7 | .32 | 16.6 | Gravities at 15° C. 300° C. to asphalt, 40 p. ct. Calorific value per c. c., 9,889. Viscosity by Redwood viscometer 247 at 15° C. | 385 |
| 0 | ...... | 27.2 | ...... | 72.8 | ...... | 23.0 | Gravities at 15° C. 300° C. to asphalt, 40.4 p. ct. Water, 9.3 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C. | 386 |
| 19.5 | .735 | 31.5 | .839 | 49.0 | 1.74 | 16.9 | Gravities at 15° C. 300° C. to asphalt, 29 p. ct. Calorific value per c. c., 9,310. Viscosity by Redwood viscometer 205 at 15° C. | 387 |
| 13.0 | .7307 | [a]20.5 | .8074 | 66.5 | ...... | 25.6 | [a]150°-270° C.; above 270° C., 40 p. ct................. | 388 |
| [a]22.0 | .7400 | ...... | ...... | ...... | ...... | ...... | Gravities at 20° C. [a]62°-154° C. 62°-120° C., 10 p. ct., refractive index 1.414. Under 26 mm. pressure, 48°-116° C., 13 p. ct., sp. gr. 0.7972, refractive index 1.443; 116°-152° C., 12 p. ct., sp. gr. 0.842; 152°-198° C., 11 p. ct., sp. gr. 0.8724; 198°-255° C., 10 p. ct., sp. gr. 0.9035 at 25° C.; 255°-310° C., 6 p. ct., sp. gr. 0.9216 at 45° C.; residue, 25.4 p. ct. | 389 |
| ...... | ...... | 28.21 | .8081 | 71.79 | ...... | ...... | 300°-350° C., 2.95 p. ct. by volume, 2.7 p. ct. by weight, sp. gr. 0.8608; 200° C., 7.27 p. ct. by volume, 6 p. ct. by weight, sp. gr. 0.7649; 250° C., 9.47 p. ct. by volume, 8.07 p. ct. by weight, sp. gr. 0.8012. | 390 |
| ...... | ...... | 33.47 | .8051 | 66.53 | ...... | ...... | 300°-350° C., 6.63 p. ct. by volume, 6.21 p. ct. by weight, sp. gr. 0.8604; 200° C., 6.94 p. ct. by volume, 5.80 p. ct. by weight, sp. gr. 0.7684; 250° C., 16.84 p. ct. by volume, 14.64 p. ct. by weight, sp. gr. 0.8005. | 391 |

**383. Mineral Resources U. S. for 1896; from Bull. 11, California Min. Bur.**
**384-387. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.**
**388. California State Min. Bur., Bull. 31, Paul W. Prutzman, chemist.**
**389. Pet. Rev., Dec. 27, Clifford Richardson.**
**390, 391. California State Min. Bur., Bull. 1 (analyst not given).**

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Ventura County—Con. | | | | | | | |
| | | Sespe district—Con. | | | | | | | |
| 392 | | Four Forks | | | 0.8687 | 31.2 | Reddish brown. | | 48° C. |
| 393 | | Do | | | .9091 | 24.0 | | | |
| 394 | | Do | | | .9021 | 25.2 | | | |
| 395 | | Do | Sespe No. 2 | | .859 | 33.0 | | | |
| 396 | | Do | Tar Creek | | .833 | 38.1 | | | |
| 397 | | Do | do | | .9125 | 23.4 | | | |
| 398 | | Do | do | | .9129 | 23.3 | | | |
| 399 | | Do | Four Forks | | .9196 | 22.2 | | | |
| 400 | | Do | Kentuck | | .9015 | 25.3 | | | |
| 401 | | Do | California Oil Co. | | .9402 | 18.9 | | | |
| 402 | | Do | No. 7, Union Oil Co. of California. | 1,175 | .8701 | 30.9 | | Below 15° C. | |
| 403 | | Piru district | No. 22, Modelo Oil Co. | 1,100 | .8838 | 28.4 | | Below 15° C. | |
| 404 | | Do | Tank, sec. 8, T. 4 N., R. 18 W. | | .894 | 26.6 | | | |
| 405 | | One-half m. west of Santa Paula. | Scott & Gilmore. | | .9302 | 20.5 | | | |
| 406 | | Do | do | | .9486 | 17.6 | | | |
| 407 | | Limekiln Canyon | Santa Paula field, Eureka Oil Co. | | .8805 | 29.0 | | | |
| 408 | | Whider Canyon, 12 miles northwest of Santa Paula. | No. 6, Burrows & Sons. | 958 | .8767 | 29.7 | | Below 15° C. | |
| 409 | | Do | Garrett Tunnel, Burrows & Sons. | 1,000 | .8828 | 28.6 | | 29° C. | |
| 410 | | Ojai district | No. 4. Whidden Double. | 284 | .9759 | 13.5 | | 56° C. | |
| 411 | | Salt Marsh Canyon (near Santa Paula). | No. 11, Union Oil Co. of California. | | .9351 | 19.7 | | Below 15° C. | |
| 412 | | Timber Canyon (near Santa Paula). | No. 3, Los Angeles Pacific Rwy. Co. | | .8481 | 35.1 | | Below 15° C. | |
| 413 | | Santa Paula district | Capital crude 20, Los Angeles Pacific Rwy. Co. | 1,000 | .8900 | 27.3 | | Below 15° C. | |

392. Pet. Rev., Jan. 5, 1907, Clifford Richardson.
393, 394, 407. Mineral Resources U. S. for 1896, Frederick Salathe, analyst.
395, 396. 7th Ann. Rept. California State Min. Bur., W. D. Johnston, chemist.
397–401, 405, 406. California State Min. Bur., Bull. 11 (laboratory analysis).

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | Residuum (cubic centimeters). | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | | | | | |
| [a] 20.0 | ...... | ...... | ...... | ...... | ...... | ...... | [a] 48°-148° C.; 48°-115° C., 10 p. ct., sp. gr. 0.7483, refractive index 1.418; 115°-148° C., 10 p. ct., sp. gr. 0.7066, refractive index 1.412. Under 28 mm. pressure, 56°-96° C., 10 p. ct., sp. gr. 0.7855, refractive index 1.437; 96°-138° C., 10 p. ct., sp. gr. 0.820, refractive index 1.454; 138°-173° C., 10 p. ct., sp. gr. 0.847, refractive index 1.469; 173°-219° C., 10 p. ct., sp. gr. 0.837, refractive index 1.484; 219°-265° C., 10 p. ct., sp. gr. 0.9026, refractive index 1.502; 265°-284° C., 10 p. ct., sp. gr. 0.9214, refractive index 1.513. Residue 21.2 p. ct. | 392 |
| 6.0 | ...... | 17.1 | ...... | 76.9 | ...... | ...... | Gas distillates, 29.5 p. ct., lubricating, 34.4 p. ct., asphalt and loss, 13 p. ct. Pyridine base equals 1.75 p. ct. | 393 |
| 7.3 | 0.7368 | [a] 19.5 | 0.8140 | 73.2 | ...... | 12.4 | [a] At 330° C., gas distillates 25 p. ct., sp. gr. 0.8861; lubricating oil, 35.8 p. ct., sp. gr. 0.9091. Pyridine base equals 2.3 p. ct. | 394 |
| 27.1 | .7317 | 28.8 | .8271 | 44.1 | ...... | ...... | Below 100° C., 9.1 p. ct., sp. gr. 0.700; 100°-125° C., 9.2 p. ct., sp. gr. 0.734; 150°-200° C., 11.8 p. ct., sp. gr. 0.798, 200°-250° C., 9 p. ct., sp. gr. 0.822. | 395 |
| 22.3 | .7447 | 27.8 | .8480 | 49.9 | ...... | ...... | Below 100° C., 10 p. ct., sp. gr. 0.720; 100°-150° C., 6.8 p. ct., sp. gr. 0.755; 150°-200° C., 9.7 p. ct., sp. gr. 0.809, 200°-250° C., 11 p. ct., sp. gr. 0.856. | 396 |
| 7.6 | .735 | 33.8 | .8118 | 58.6 | ...... | ...... | 300°-350° C., 6 p. ct., sp. gr. 0.8834 | 397 |
| 8.4 | .7240 | 32.6 | .8117 | 59.0 | ...... | ...... | 300°-350° C., 4 p. ct | 398 |
| Tr. | ...... | 33.4 | .8044 | 66.6 | ...... | ...... | 300°-350° C., 6.6 p. ct., sp. gr. 0.8604 | 399 |
| 6.0 | .7200 | 30.8 | .8082 | 63.2 | ...... | ...... | 300-350° C., 2.5 p. ct., sp. gr. 0.8662 | 400 |
| Tr. | ...... | 28.1 | .8112 | 71.9 | ...... | ...... | 300°-350° C., 2.9 p. ct., sp. gr. 0.8608 | 401 |
| 19.5 | .7353 | 30.0 | .8299 | 50.5 | ...... | 13.2 | 300° C. to asphalt, 34.9 p. ct., sp. gr. 0.8769. Viscosity by Redwood viscometer 77 at 15° C. | 402 |
| 23.3 | .7523 | 35.5 | .8514 | 41.2 | ...... | 16.6 | 300° C. to asphalt, 24.2 p. ct., sp. gr. 0.8911. Viscosity by Redwood viscometer 63 at 15° C. | 403 |
| 13.8 | .7392 | [a] 32.4 | .8197 | 53.8 | ...... | 12.9 | [a] 150°-270° C.; above 270° C., 38.9 p. ct | 404 |
| Tr. | ...... | 28.0 | .8272 | 72.0 | ...... | ...... | 300°-350° C., 3.2 p. ct | 405 |
| Tr. | ...... | 6.0 | .8465 | 94.0 | ...... | ...... | 300°-350 C., 7.6 p. ct | 406 |
| 14.1 | ...... | 26.4 | ...... | 59.5 | ...... | ...... | Gas distillate, 24 p. ct.; lubricating distillate, 27 p. ct.; asphalt and loss, 8.5 p. ct. Pyridine base equals 1.44 p. ct. | 407 |
| 26.6 | .7305 | 27.4 | .8431 | 46.0 | .72 | 14.8 | Gravities at 15° C. 300° C. to asphalt, 30 p. ct., sp. gr. 0.892. Calorific value per c. c., 9,332. Viscosity by Redwood viscometer 77 at 15° C. | 408 |
| 12.3 | .7798 | 44.6 | .8437 | 43.1 | ...... | 6.2 | Gravities at 15° C. 300° C. to asphalt, 37.3 p. ct., sp. gr. 0.9014. Viscosity by Redwood viscometer 53 at 15° C. | 409 |
| 0 | ...... | 31.0 | .8620 | 69.0 | 1.48 | 38.1 | Gravities at 15° C. 300° C. to asphalt, 30.8 p. ct., sp. gr. 0.8925. Calorific value per c. c., 8,892. Viscosity by Redwood viscometer over 1,800 at 15° C. | 410 |
| 10.1 | .7571 | 25.9 | .8558 | 64.0 | ...... | 20.7 | Gravities at 15° C. 300° C. to asphalt, 40.1 p. ct., sp. gr. 0.9156. Viscosity by Redwood viscometer 878 at 15° C. | 411 |
| 30.3 | .7318 | 29.3 | .8324 | 40.4 | .... | 10.6 | All gravities at 15° C. 300° C. to asphalt 28 p. ct., sp. gr. 0.8875. Viscosity by Redwood viscometer 45.8 at 15.5° C. | 412 |
| 25.8 | .7545 | 28.6 | .8535 | 45.6 | ...... | 13.0 | Gravities at 15° C. 300° C. to asphalt 31.8 p. ct., sp. gr. 0.9154. Viscosity by Redwood viscometer 61.6 at 15° C. | 413 |

**402, 403, 408, 410, 411. California State Min Bur., Bull. 31, H. N. Cooper, chemist.**
**412. California State Min. Bur., Bull. 31, Paul W. Prutzman.**
**413. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.**

*Analyses of petroleum from various*

| Serial No. | No. of specimen. | Location of well. | Designation of well. | Depth of well (feet). | Physical properties. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gravity. | | Color. | Flash point. | Begins to distill at— |
| | | | | | Specific. | Degrees Baumé. | | | |
| | | CALIFORNIA—continued. | | | | | | | |
| | | Ventura County—Con. | | | | | | | |
| 414 | ... | Santa Paula district. | Sec. 11, T. 4 N., R. 22 W., tank. | ........ | 0.9873 | 11.8 | .................. | ........ | ........ |
| 415 | ... | Do | Well | ........ | .9021 | 25.2 | Green | ........ | ........ |
| 416 | ... | Do | Pipe line | ........ | .8997 | 25.6 | .................. | ........ | ........ |
| 417 | ... | Do | Well | ........ | .8974 | 26.0 | .................. | ........ | ........ |
| 418 | ... | Do | do | ........ | .8929 | 26.8 | .................. | ........ | ........ |
| 419 | ... | Do | Sec. 17, T. 4 N., R. 21 W., tank. | ........ | .8895 | 27.4 | .................. | ........ | ........ |
| 420 | ... | Sulphur Mountain district. | Tunnel in Wheeler Canyon. | ........ | ........ | ........ | .................. | ........ | ........ |
| 421 | ... | Do | No. 1, Sulphur Mountain Petroleum Co. | 2,150 | .9486 | 16.6 | .................. | Below 15° C. | ........ |
| 422 | ... | Do | Pinkerton tunnel. | ........ | .9333 | 20.0 | Green | ........ | ........ |
| 423 | ... | Do | do | ........ | .9398 | 19.0 | .................. | ........ | ........ |
| 424 | ... | Do | do | ........ | .9333 | 20.0 | Green | ........ | ........ |
| 425 | ... | Do | Magie tunnel | ........ | .9773 | 13.3 | .................. | ........ | ........ |
| 426 | ... | West of Santa Paula | O'Hara well | ........ | .9435 | 18.4 | .................. | ........ | ........ |
| 427 | ... | Do | do | ........ | .9769 | 13.3 | .................. | ........ | ........ |
| 428 | ... | Silverthread district | ........ | ........ | .9366 | 19.5 | .................. | ........ | ........ |
| 429 | ... | Do | ........ | ........ | .9255 | 21.3 | .................. | ........ | ........ |
| 430 | ... | Do | ........ | ........ | .9369 | 19.4 | .................. | ........ | ........ |
| 431 | ... | Do | ........ | ........ | .9442 | 18.3 | .................. | ........ | ........ |
| 432 | ... | Do | ........ | ........ | .9590 | 16.0 | .................. | ........ | ........ |
| 433 | ... | Torrey Canyon district. | No. 52, Union Oil Co. of California. | 1,410 | .8758 | 29.9 | .................. | Below 15° C. | ........ |
| 434 | ... | Do | ........ | ........ | .8650 | 31.9 | Dark reddish brown. | ........ | 47° C. |
| 435 | ... | Do | ........ | ........ | .8917 | 27.0 | .................. | ........ | ........ |
| 436 | ... | Do | Tank | ........ | .9174 | 22.6 | .................. | ........ | ........ |
| 437 | ... | Do | Well | ........ | .9097 | 23.9 | .................. | ........ | ........ |
| 438 | ... | Do | do | ........ | .8855 | 28.1 | .................. | ........ | ........ |

414-419. California State Min. Bur., Bull. 31, Paul W. Prutzman.
420. Am. Jour. Sci., 3d ser., vol. 48, p. 252, S. F. Peckham.
421. California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
422-432. California State Min. Bur., Bull. 11 (analyst not given).

*parts of the United States*—Continued.

| Distillation by Engler's method (by volume). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| To 150° C. | | 150°-300° C. | | | | | | |
| Cubic centimeters. | Specific gravity. | Cubic centimeters. | Specific gravity. | Residuum (cubic centimeters). | Sulphur (per cent). | Asphalt (per cent). | Remarks. | Serial No. |
| 0 | ...... | 0 | ([a]) | 100.0 | ..... | 41.7 | [a] 150°-270° C.; above 270° C. 56 p. ct., sp. gr. 0.965 | 414 |
| 12.5 | 0.7621 | [a] 25.5 | 0.8353 | 62.0 | ..... | 11.8 | [a] 150°-270° C.; above 270° C. 50.2 p. ct., sp. gr. 0.915 | 415 |
| 10.0 | .7427 | [a] 24.0 | .8163 | 66.0 | ..... | 25.3 | [a] 150°-270° C.; above 270° C. 38 p. ct., sp. gr. 0.8761 | 416 |
| 10.0 | .7527 | [a] 27.0 | .8294 | 63.0 | ..... | 16.0 | [a] 150°-270° C.; above 270° C. 44 p. ct., sp. gr. not given. | 417 |
| 13.0 | .7609 | [a] 26.5 | .8284 | 60.5 | ..... | 11.0 | [a] 150°-270° C.; above 270° C. 45.9 p. ct | 418 |
| 19.4 | .7400 | [a] 26.1 | .8230 | 54.5 | ..... | 18.8 | [a] 150°-270° C.; above 270° C. 35.2 p. ct | 419 |
| ...... | ...... | ...... | ...... | ...... | ..... | ..... | Average composition, hydrogen, 11.819 p. ct; carbon, 86.934 p. ct.; nitrogen, 1.1095 p. ct. | 420 |
| 7.9 | .7576 | 44.3 | .8702 | 47.8 | ..... | 25.0 | Gravities at 15° C. 300° C. to asphalt 20 p. ct., sp. gr. 0.9302. Viscosity by Redwood viscometer 2240 at 15° C. | 421 |
| ...... | ...... | 27.6 | .8242 | 72.4 | | | 300°-350° C., 5 p. ct., sp. gr. 0.862 | 422 |
| Tr. | ...... | 26.8 | .8351 | 74.2 | ..... | ..... | 300°-350° C., 5 p. ct, sp. gr. 0.8701 | 423 |
| Tr. | ...... | 27.6 | .8242 | 73.4 | ..... | ..... | 300°-350° C., 5 p. ct., sp. gr. 0.8620 | 424 |
| Tr. | ...... | Tr. | ...... | 100.0 | ..... | ..... | 300°-350° C., 16 p. ct., sp. gr. 0.8701 | 425 |
| Tr. | ...... | 26.4 | .8252 | 73.6 | ..... | ..... | 300°-350° C., 6 p. ct., sp. gr. 0.8738 | 426 |
| Tr. | ...... | 13.0 | .8530 | 87.0 | ..... | ..... | 300°-350° C., 3 p. ct | 427 |
| 5.0 | .7560 | 23.2 | .8006 | 71.8 | ..... | ..... | 300°-350° C., 5.8 p. ct., sp. gr. 0.8764 | 428 |
| 7.0 | .7428 | 28.2 | .8007 | 64.8 | ..... | ..... | 300°-350° C., 6.4 p. ct., sp. gr. 0.8612 | 429 |
| Tr. | ...... | 34.2 | .8157 | 65.8 | ..... | ..... | 300°-350° C., 7.6 p. ct., sp. gr 0.8791 | 430 |
| Tr. | ...... | 27.6 | .8117 | 72.4 | ..... | ..... | 300°-350° C., 4 p. ct., sp. gr. 0.8790 | 431 |
| Tr. | ...... | 5.0 | .8500 | 95.0 | ..... | ..... | 300°-350° C., 7 p. ct., sp. gr. 0.8780 | 432 |
| 18.7 | .7394 | 28.1 | .8312 | 63.2 | 0.71 | 16.6 | 300° C. to asphalt, 33.7 p. ct., sp. gr. 0.8720. Calorific value per c. c., 9,293. Viscosity by Redwood viscometer 103 at 15° C. | 433 |
| [a] 18.4 | .7418 | ...... | ...... | ...... | ..... | ..... | [a] 47°-116° C., 6 p. ct., sp. gr. 0.7200, refractive index 1.412; 116°-145° C., 12.4 p. ct., sp. gr. 0.7523, refractive index 1.428. Under 26 mm. pressure 36°-94° C., 12.7 p. ct., sp. gr. 0.7912, refractive index 1.440; 94°-132° C., 14 p. ct., sp. gr. 0.8255, refractive index 1.458, 132°-195° C., 17.6 p. ct., sp. gr. 0.8520, refractive index 1.475; 195°-242° C., 15 p. ct., sp. gr. 0.8808, refractive index 1.491; 242°-280° C., 15 p. ct., sp. gr. 0.8981 (at 40° C.), refractive index 1.504; 280°-310° C., 6.2 p. ct. (solid hydrocarbon), sp. gr. 0.9156, refractive index 1.523. | 434 |
| 9.2 | ...... | 21.5 | ...... | 60.3 | ..... | ..... | No temperature given. Gas distillate, 26 p. ct.; lubricating distillate, 30.3 p. ct.; asphalt and loss, 13 p. ct. Pyridine bases equal 1.52 p. ct. | 435 |
| 0 | ...... | [a] 30.0 | .8294 | 70.0 | ..... | 15.4 | [a] 150°-270° C.; above 270° C., 53.2 p. ct | 436 |
| 7.2 | .7609 | [a] 26.7 | .8333 | 66.1 | ..... | 25.5 | [a] 150°-270° C.; above 270° C., 38.9 p. ct | 437 |
| 16.6 | .7621 | [a] 23.6 | .8245 | 59.8 | ..... | 21.1 | [a] 150°-270° C.; above 270° C., 35.7 p. ct | 438 |

**433.** California State Min. Bur., Bull. 31, H. N. Cooper, chemist.
**434.** Pet. Rev., Dec. 27, 1906, Clifford Richardson.
**435.** Mineral Resources U. S. for 1896; from Bull. 11, California State Min. Bur.
**436–438.** California State Min. Bur., Bull. 31, Paul W. Prutzman.

## PETROLEUM INDUSTRY IN FOREIGN COUNTRIES.

### CANADA.

*Production.*—In the following table is given the total production of crude petroleum in Canada from 1902 to 1907, inclusive, as reported by the geological survey of Canada:

*Production of crude petroleum in Canada, 1902–1907.*

| Year. | Quantity (barrels). | Value. | Average price per barrel. |
|---|---|---|---|
| 1902 | 530,624 | $951,190 | $1.79¼ |
| 1903 | 486,637 | 1,048,974 | 2.15½ |
| 1904 | 552,575 | 984,310 | 1.78 |
| 1905 | 634,095 | 856,028 | 1.35 |
| 1906 | 569,753 | 761,760 | 1.337 |
| 1907 | 788,872 | 1,080,755 | 1.37 |

*Prices.*—The average monthly prices per barrel from 1904 to 1907, inclusive, are given in the following table:

*Average monthly prices per barrel for crude oil at Petrolia, 1904–1907.*

| Month. | 1904. | 1905. | 1906. | 1907. | Month. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|---|---|---|
| January | $2.36 | $1.42 | $1.38 | $1.34 | August | $1.54 | $1.30 | $1.38 | $1.38 |
| February | 2.34 | 1.37 | 1.38 | 1.35 | September | 1.52 | 1.33 | 1.34 | 1.38 |
| March | 2.24 | 1.37 | 1.38 | 1.37 | October | 1.56 | 1.39 | 1.34 | 1.38 |
| April | 2.17 | 1.33 | 1.40 | 1.38 | November | 1.55 | 1.39 | 1.34 | 1.38 |
| May | 2.13 | 1.31 | 1.40 | 1.38 | December | 1.53 | 1.38 | 1.34 | 1.38 |
| June | 1.84 | 1.30 | 1.40 | 1.38 | | | | | |
| July | 1.59 | 1.30 | 1.38 | 1.37 | The year | 1.78 | 1.35 | 1.3734 | 1.37 |

In the following table, furnished by the Imperial Oil Company (Limited), is given the production of petroleum in Canada during the years 1906 and 1907, by districts. The increase shown by the new Merlin and Coatsworth district more than offset the natural decline in all the older fields:

*Production of crude petroleum in Canada in 1906 and 1907, by districts, in barrels.*

| District. | 1906. | 1907. |
|---|---|---|
| Dutton | 18,597 | 14,698 |
| Leamington (Staples and Comber) | 35,958 | 16,210 |
| Bothwell | 43,836 | 40,556 |
| Richardson (Chatham) | 1,376 | 940 |
| Thamesville | 1,585 | 1,139 |
| Moore Township | 53,030 | 32,720 |
| Oil Springs | 68,100 | 55,813 |
| Merlin (E. Tilbury and Raleigh) | 115,400 | 344,358 |
| Coatsworth (Romney) | | 49,784 |
| Petrolia (includes all districts not enumerated above) | 247,446 | 206,285 |
| Total | 585,328 | 762,503 |

## MEXICO.

Petroliferous lands extend from the hacienda of San Jose de las Ruinas, in Central Tamaulipas, to the district of Valles in San Luis Potosi (where the Ebano oil deposits are beng worked) through the counties of Uzuluama, Tuxpan, and Papantla in Veracruz. Farther to the south another region is found which embraces the Veracruz counties of Acayucan and Minatitlan and extends southward through the States of Tabasco, Campeche, and Chiapas. Petroleum has also been found in small quantities in the Federal district of Mexico, Jalisco, and Oaxaca, and at other points along the isthmus of Tehuantepec. Some recent discoveries in the States of Chihuahua and Coahuila show the existence of paraffin oil in the country.

Statistics of the petroleum development in Mexico in 1907 are not available, but it is known from evidence at hand that there was a considerable growth of the industry. There is small encouragement for prospectors for oil in that country as the land is all held in enormous tracts, and in order to obtain a working basis for wild-catting the operator either has to purchase a big tract of land outright or enter into burdensome leases. Up to the present time oil development and wild-catting are being done by a few large concerns which own outright the land they are developing.

There are at present five oil companies in operation. The most important is the Mexican Petroleum Company, whose main field of operation is located near the port of Tampico, its headquarters being at the new town of Ebano, which the company established. Other fields of this company are situated near Laguna de Tamiahua, south of Tampico, and near Tuxpan, a little farther south. This company has bored a number of wells, the capacities of which are estimated all the way from 500 to 1,000 barrels each per day. It is reported that a gusher with a capacity of 1,800 barrels per day was brought in early in 1907 in the Ebano field. Some of the wells flow naturally; others are pumped. The output of the company is not known, but that it is large appears from the fact that in addition to keeping its refinery constantly supplied it furnishes from 3,000 to 4,000 barrels of oil daily to the Mexican Central Railroad for use as fuel in its locomotives and also supplies the crude oil market for a large portion of Mexico. The Mexican Central Raliroad is using oil-burning engines on its main line from Torreon to the City of Mexico, and in its branches from Mexico to Cuernavaca and Balsas, from Tampico to Aguascalientes, and from Mexico to Guadalajara and Tuxpan-Colima. Storage tanks are being prepared at Guadalajara, Yurecuaro, Zapotlan, and La Vega, and metal delivery tanks are being erected. Some oil has been unloaded at Guadalajara and Zacatecas. The Mexican Petroleum Company sells a small part of its product, reduced to asphalt, to the Mexican Paving and Construction Company for paving purposes in the cities of Mexico and Guadalajara. The Mexican Petroleum Company is going to estabilsh a plant in Ebano for producing 100 tons of pure asphalt daily. This asphalt finds a ready market in Europe for paving and painting uses. Some of it has been sold for painting the bottoms of the warships both of the United States Navy and of the British navy.

Another large company operating in Mexico is Messrs. Pearson and Son (Limited), operators of the National Tehuantepec Railroad, whose oil fields are at Minatitlan in southern Veracruz, and in Tabasco.

Their main oil camp is located near San Cristobal, not far from the Tehuantepec railroad, where the company is drilling many test wells, as also at other points in the field. This oil is of a little lighter grade than that of the Ebano and Tuxpan fields. The oil of southern Veracruz, especially that of Minatitlan is being stored preparatory to the completion of a refinery at Minatitlan, near the City of Mexico, which is to be the largest ever erected in the Republic. It will be complete in every department. The company has completed a pipe line from the San Cristobal fields to the refinery, where there is one 42,000-barrel tank filled with oil. The Minatitlan oil is said to require considerable refining, being very rich in naphtha. The company was very active during the year 1907 in drilling on its various holdings in Veracruz and Tabasco, and is erecting large steel storage tanks at Veracruz. Some of its wells are of the gusher variety. It is now supplying the locomotives on the National Tehuantepec Railroad with fuel oil from its field. When the new fuel was introduced on this road the oil supply was obtained entirely from Texas. The company has made a contract to supply fuel oil for the engines of the Mexican Railroad from Mexico city to Veracruz.

Another company is the Furber Company, which is operating on land near Papantla, State of Veracruz, where oil was discovered a few years ago. This company has made no effort to develop its holdings owing to the remoteness of the property from railroad transportation facilities. A new railroad is projected to be built from Teziutlan to the port of Nautla, and it will pass close to the oil field. It is said that oil was found in each of the few wells that were bored. Tankage is now being erected and possibly a pipe line will be built to the sea.

Oil was recently developed in a well that was bored near Ojinaga, State of Chihuahua. The quantity is said to be small. Another well is being bored in the same locality.

A test for oil on land located near Pochutla, a few miles from the Pacific Ocean, in the State of Oaxaca, is reported to have been successful in locating pay sand. The new field is close to Port Angel. The surface indications in the oil belt of Mexico, as described by Dr. Ezequiel Ordonez, of the Mexican Geological Survey, are mounds in the extensive peneplains of these States. These differ from Texas mounds in having a central chimney of basalt. Most of the oil found is of asphaltic base, very viscous, and used only for fuel and lubricating. The common distillation produces about 50 per cent of asphalt of the best quality for paving and painting purposes. It seems very probable that the oil found now in small quantities in Tabasco will be found in larger quantities in the future and of lighter grade, with a good percentage of paraffin, though not light enough to be very good for illuminating. The actual oil-producing fields of Mexico are very few and all give that black viscous asphaltic product called "chapopote" or "betun," except the slight developments in Chihuahua.

It was difficult to obtain complete information regarding the output of the oil fields of Mexico in 1907, but the production is estimated at 1,000,000 barrels, which is all fuel oil. The greater part of this crude oil was produced in the Ebano field.

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexico in 1905, 1906, and 1907:

*Imports of petroleum and its products from the United States into Mexico, years ending June 30, 1905, 1906, and 1907.*

[Gallons.]

| Kind of oil. | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Crude | 14,036,517 | $786,613 | 14,366,495 | $766,353 | 19,992,434 | $1,037,226 |
| Naphtha | 56,555 | 11,982 | 100,674 | 20,183 | 133,147 | 22,069 |
| Illuminating | 461,266 | 74,291 | 2,095,939 | 203,241 | 2,495,070 | 252,020 |
| Lubricating | 697,382 | 137,614 | 1,097,746 | 212,970 | 1,255,991 | 236,074 |
| Total | 15,251,720 | 1,010,500 | 17,660,854 | 1,202,747 | 23,876,642 | 1,547,389 |

*Quantity and value of mineral oils imported from the United States into Mexico, 1903 to 1907, inclusive.*

[Gallons.]

| Year ending June 30— | Mineral. | | | |
|---|---|---|---|---|
| | Crude. | | Refined, including residuum. | |
| 1903 | 9,859,154 | $559,332 | 1,153,015 | $218,272 |
| 1904 | 10,938,448 | 663,575 | 1,179,894 | 222,005 |
| 1905 | 14,036,517 | 786,613 | 1,216,421 | 224,061 |
| 1906 | 14,366,495 | 766,353 | 3,295,325 | 616,479 |
| 1907 | 19,992,434 | 1,037,226 | 3,906,472 | 511,990 |

## PERU.

The oil production of Peru, which declined from 1901 to 1906, is increasing again, due to better refining facilities.

*Production of petroleum in Zorritos oil field of Peru, 1901-1907, in gallons.*

| Year. | Crude petroleum. | Refined.[a] | Gasoline. | Benzine. |
|---|---|---|---|---|
| 1901 | 3,135,000 | 282,430 | 19,060 | |
| 1902 | 2,489,500 | 373,250 | 25,920 | |
| 1903 | 2,060,000 | 276,100 | 61,745 | |
| 1904 | 2,080,000 | 365,000 | 46,200 | |
| 1905 | 1,584,242 | 300,000 | 29,570 | |
| 1906 | 1,781,600 | 350,000 | 54,000 | 10,000 |
| 1907 | 2,750,000 | 420,000 | 101,000 | 20,000 |

[a] Kerosene.

## RUSSIA.

The production, which showed such a sharp decline in 1905 in consequence of strikes and other internal disturbances, increased again in 1906 and again slightly in 1907. The labor disturbances were still a pronounced factor and competition from the increased activity in Roumania and Galicia was felt, but both were more than balanced by the drilling in of gushers of phenomenal size. The average depth of wells increased from 896 feet in 1896 to 1,169 feet in 1906. In the Bibi-Eibat field the increase in depth is from an average of 1,141 feet in 1896 to 1,757 feet in 1906. The deepest well is 2,310 feet.

Russian oil trade was favorably influenced by higher prices for all products, but the year was not a satisfactory one, as is shown in the consular report of Consul Stevens, which can be obtained from the Department of Commerce and Labor.

*Production of crude petroleum in Russia, 1903–1907, by fields.*

| Year. | Baku. | | Groznyi. | | Total. | |
|---|---|---|---|---|---|---|
| | Poods.[a] | Barrels of 42 gallons. | Poods. | Barrels of 42 gallons. | Poods. | Barrels of 42 gallons. |
| 1903 | 596,581,155 | 71,618,386 | 33,094,000 | 3,972,870 | 629,675,155 | 75,591,256 |
| 1904 | 614,115,445 | 73,723,290 | 40,095,331 | 4,813,365 | 654,210,776 | 78,536,655 |
| 1905 | 414,762,000 | 49,791,356 | 43,057,052 | 5,168,914 | 457,819,052 | 54,960,270 |
| 1906 | 447,520,000 | 53,723,889 | 38,373,603 | 4,606,675 | [b] 490,614,603 | 58,897,311 |
| 1907 | 476,002,000 | 57,143,097 | 39,214,612 | 4,707,637 | 515,216,612 | 61,850,734 |

[a] 8.33 poods crude=1 United States barrel of 42 gallons.
8 poods illuminating oil=1 United States barrel of 42 gallons.
8.18 poods lubricating oil=1 United States barrel of 42 gallons.
9 poods residuum=1 United States barrel of 42 gallons.
7.50 poods naphtha=1 United States barrel of 42 gallons.
8.3775 poods other products=1 United States barrel of 42 gallons, estimated.
1 pood=36.112 pounds.
1 kopek=1.958 cents.

[b] Includes 4,721,000 poods, or 566,747 barrels, produced in Bereki and Tchimion oil fields in 1906.

The total production of crude petroleum on the Apsheron Peninsula and the shipments of the chief petroleum products from Baku to all points from 1902 to 1907 have been as follows:

*Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1902–1907, in barrels.*

| Year. | Production. | Shipments from Baku. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Illuminating. | Lubricating. | Other products. | Residuum. | Crude oil. | Total. |
| 1902 | 76,414,045 | 15,026,000 | 1,750,367 | 298,657 | 38,049,555 | 4,090,036 | 59,214,615 |
| 1903 | 71,618,386 | 18,313,125 | 2,032,347 | 117,815 | 33,763,778 | 3,172,509 | 57,399,574 |
| 1904 | 73,723,290 | 19,205,250 | 1,896,455 | 159,355 | 33,622,111 | 2,249,340 | 57,132,511 |
| 1905 | 49,791,356 | 9,209,125 | 1,303,912 | 150,045 | 29,555,777 | 2,897,359 | 43,116,218 |
| 1906 | 53,723,889 | 8,941,125 | 1,847,799 | 179,289 | 22,697,667 | 4,001,441 | 37,667,321 |
| 1907 | 57,143,097 | 11,450,019 | 1,724,664 | 565,689 | 27,833,892 | 4,290,500 | 45,864,764 |

The division of the production among the districts of the Apsheron Peninsula or Baku field is as follows:

*Production of the several districts of the Apsheron Peninsula, 1902–1907, in barrels.*

| Year. | Balakhani. | Sabunchi. | Romani. | Bibi-Eibat. | Binagadi. | Total. |
|---|---|---|---|---|---|---|
| 1902 | 12,185,354 | 32,071,908 | 16,800,000 | 15,298,200 | 58,583 | 76,414,045 |
| 1903 | 10,642,274 | 27,663,859 | 14,398,951 | 18,882,294 | 31,008 | 71,618,386 |
| 1904 | 9,848,380 | 26,029,292 | 16,063,505 | 21,745,618 | 36,495 | 73,723,290 |
| 1905 | 6,866,747 | 16,494,310 | 11,230,732 | 15,175,558 | 24,009 | 49,791,356 |
| 1906 | 8,142,017 | 18,739,015 | 11,489,796 | 15,317,647 | 35,414 | 53,723,889 |
| 1907 | 8,594,118 | 22,036,734 | 10,750,901 | 15,761,344 | ............ | 57,143,097 |

*Production of crude petroleum from pumping and flowing wells in the Baku field in 1906 and 1907, by districts.*

[Barrels of 42 gallons.]

| Year. | Balakhani. | Sabunchi. | Romani. | Bibi-Eibat. | Total. |
|---|---|---|---|---|---|
| PUMPING. | | | | | |
| 1906 | 8,142,017 | 18,513,445 | 10,436,615 | 15,282,113 | [a] 52,409,604 |
| 1907 | 8,594,118 | 21,676,950 | 10,353,782 | 15,137,215 | 55,762,065 |
| FLOWING. | | | | | |
| 1906 | ............ | 225,570 | 1,053,181 | 35,534 | 1,314,285 |
| 1907 | ............ | 359,784 | 397,119 | 624,129 | 1,381,032 |

[a] Includes 35,414 barrels in Binagadi.

*Groznyi field.*—The following table shows the production in the Groznyi field in 1906 and 1907:

*Production of petroleum in the Groznyi oil field in 1906 and 1907, in barrels.*

| Wells. | 1906. | | 1907. | |
|---|---|---|---|---|
| | *Poods.* | *Barrels.* | *Poods.* | *Barrels.* |
| Pumping | 30,041,912 | 3,606,472 | 33,840,762 | 4,062,517 |
| Flowing | 8,331,691 | 1,000,203 | 5,373,850 | 645,120 |
| Total | 38,373,603 | 4,606,675 | 39,214,612 | 4,707,637 |

There was at the close of 1907 a total of 271 wells in the Groznyi oil field, of which 205 were producing.

The following table shows the deliveries of petroleum and petroleum products from the Groznyi district in 1906 and 1907:

*Deliveries of petroleum and petroleum products from the Groznyi district in 1906 and 1907, in barrels.*

| Year. | Crude oil. | Kerosene. | Benzine. | Residuals. | Total. |
|---|---|---|---|---|---|
| 1906 | 150,825 | 363,649 | 178,568 | 2,462,484 | 3,155,526 |
| 1907 | 209,584 | 243,170 | 342,306 | 2,199,756 | 2,994,816 |

The following table shows the shipments of petroleum from Novorossisk in 1906 and 1907:

*Shipments of petroleum from Novorossisk in 1906 and 1907, in barrels.*

| Year. | Crude oil. | Illuminating. | Benzine. | Residuals. | Total. |
|---|---|---|---|---|---|
| 1906 | 486 | 435,670 | 86,230 | 347,858 | 870,244 |
| 1907 | 770 | 246,246 | 299,658 | 209,812 | 756,486 |

The receipts of oils at Batum and the deliveries therefrom for the past three years are given in the following table:

*Receipts and deliveries of petroleum at Batum, 1905–1907.*

| Year. | Receipts. | | Deliveries. | |
|---|---|---|---|---|
| | *Poods.* | *Barrels.* | *Poods.* | *Barrels.* |
| 1905 | 25,743,344 | 2,647,900 | 36,763,124 | 3,781,340 |
| 1906 | 31,607,655 | 3,247,644 | 30,999,197 | 3,188,500 |
| 1907 | 39,467,788 | 4,059,534 | 37,073,586 | 3,813,283 |

*Stocks at Batum.*—The following were the stocks of petroleum products held at Batum at the close of the years 1906 and 1907, in poods and barrels:

*Stocks of petroleum at Batum, December 31, 1906 and 1907.*

| | 1906. | | 1907. | |
|---|---|---|---|---|
| | *Poods.* | *Barrels.* | *Poods.* | *Barrels.* |
| Illuminating | 4,408,999 | 551,125 | 4,232,000 | 529,000 |
| Lubricating | 1,160,168 | 141,830 | 1,273,000 | 155,623 |
| Vaseline | | | 69,000 | 7,909 |
| Residuals | 257,217 | 28,580 | 257,000 | 28,556 |
| Total | 5,826,384 | 721,535 | 5,831,000 | 721,088 |

*Well record.*—In the table following is given a statement of the number and condition of the wells on the Apsheron Peninsula on December 31, 1906 and 1907:

*Number and condition of wells in the Baku fields in years ending December 31, 1906 and 1907.*

| Condition of wells. | Balakhani-Sabunchi. | | Romani. | | Bibi-Eibat. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. | 1906. | 1907. |
| Completed | 107 | 145 | 40 | 32 | 29 | 37 | 176 | 214 |
| Producing | 1,863 | 2,220 | 366 | 334 | 372 | 375 | [a]2,613 | [a]2,941 |
| Trial pumping | 395 | 878 | 108 | 185 | 124 | 235 | 627 | 1,298 |
| Drilling | 345 | 162 | 96 | 34 | 270 | 41 | 711 | 237 |
| Drilling deeper | 104 | 191 | 28 | 78 | 77 | 99 | 209 | 368 |
| Cleaning out and repairing | 336 | 413 | 163 | 166 | 178 | 195 | 677 | 774 |
| Standing idle | 1,243 | 1,020 | 227 | 163 | 329 | 147 | 1,799 | 1,330 |
| Rigs up, ready for drilling | 122 | 167 | 30 | 32 | 44 | 33 | 196 | 232 |
| New wells sunk | 155 | 196 | 37 | 39 | 57 | 40 | 249 | 275 |
| Length of wells drilled, in feet | 164,976 | 233,574 | 57,694 | 70,310 | 114,058 | 118,302 | 336,728 | 422,186 |

[a] Includes 12 wells in Binagadi.

*Stocks in Baku field.*—The stocks of petroleum and petroleum products in the Baku field at the close of 1906 and 1907 were as follows:

*Stocks of petroleum in Baku, December 31, 1906 and 1907, in barrels.*

| | 1906. | 1907. |
|---|---|---|
| At oil wells: Crude | 930,965 | 720,288 |
| At refineries: | | |
| Crude | 2,187,339 | 2,028,812 |
| Illuminating | 953,751 | 1,225,000 |
| Lubricating | 387,217 | 268,949 |
| Residuals | 4,669,882 | 3,822,222 |
| Other products | 92,762 | 179,051 |
| Total | 9,221,916 | 8,244,322 |

## AUSTRIA-HUNGARY.

After remaining practically stationary for several years the Galician oil product increased greatly in 1907.

In the following table is given a statement of the production of crude petroleum in Galicia from 1902 to 1907, inclusive, as ascertained by the statistical bureau of the Galizischer Landes-Petroleum-Verein, Lemberg:

*Production of crude petroleum in Galicia, 1902–1907.*

| Year. | Metric centners. | Barrels of 42 gallons. | Year. | Metric centners. | Barrels of 42 gallons. |
|---|---|---|---|---|---|
| 1902 | 5,760,600 | 4,142,159 | 1905 | 8,017,904 | 5,765,317 |
| 1903 | 7,279,710 | 5,234,475 | 1906 | 7,604,432 | 5,467,967 |
| 1904 | 8,271,167 | 5,947,383 | 1907 | 11,750,974 | 8,449,538 |

1 metric centner of crude petroleum=0.71905 barrels of 42 gallons.

In the following table is given the production of crude petroleum in Galicia in 1907; the stocks of crude, deliveries, and consumption, by fields, in tons:

*Production, stocks, deliveries, and consumption of crude oil in Galicia in 1907, by fields.*

| Field. | Production. | | | Crude stock Dec. 31, 1906. | Deliveries in 1907. | Consumption and loss. | Crude stock Dec. 31, 1907. |
|---|---|---|---|---|---|---|---|
| | First half year | Second half year. | Total. | | | | |
| East Galicia: | | | | | | | |
| Boryslaw-Tustanowice | 391,300 | 620,290 | 1,011,590 | 345,602 | 748,090 | 25,650 | 601,108 |
| Schodnica | 20,450 | 19,200 | 39,650 | 13,833 | 36,925 | 2,350 | 7,130 |
| Urycz | 6,950 | 6,560 | 13,510 | 10,295 | 18,891 | 1,950 | 2,070 |
| Mraznica | 700 | 790 | 1,490 | 604 | 1,716 | 280 | 68 |
| Other East Galician fields | 6,300 | 5,930 | 12,230 | 1,062 | 10,421 | 1,130 | 1,321 |
| West Galicia: | | | | | | | |
| Potok | 7,330 | 6,520 | 13,850 | 3,901 | 15,850 | 560 | 1,261 |
| Rogi | 4,313 | 4,720 | 9,033 | 1,116 | 11,095 | 880 | 1,504 |
| Rowne | 841 | 1,140 | 1,981 | 177 | 1,108 | 150 | 820 |
| Tarnawa-Wielopole-Zagorz | 7,550 | 9,840 | 17,390 | 4,559 | 17,649 | 700 | 3,219 |
| Krosno | 14,660 | 15,300 | 29,960 | 10,643 | 26,442 | 2,390 | 10,971 |
| Other West Galician fields | 12,640 | 12,650 | 25,290 | 7,745 | 23,159 | 1,500 | 7,426 |
| Total | 473,034 | 702,940 | 1,175,974 | 399,547 | 911,646 | 37,540 | 636,898 |

In the following table are given the imports into and exports of petroleum products from Austria-Hungary in 1907:

*Imports into and exports of petroleum from Austria-Hungary in 1907, in metric tons.*

| Kind. | Imports. | Exports. |
|---|---|---|
| Illuminating oils | 141,572 | 3,180 |
| Lubricating and other oils | 64,564 | 26,537 |
| Benzine | 19,528 | .......... |
| Paraffin | 14,736 | 521 |
| Total | 240,400 | 30,238 |

## ROUMANIA.

The production of crude petroleum in Roumania has increased steadily and rapidly since the beginning of the present decade. The increase has been due to the influx of foreign capital, including American, and also to the fostering aid of the Roumanian government. Probably no other government in the history of oil production has invested so much money in proportion to the product in facilitating the production, refining, and distribution of petroleum and its products. This is due in part to the wish on the part of Prime Minister Sturdza to provide employment for the native engineers and other professional men now being turned out by the various educational institutions at home and abroad. The government is also owner of a considerable portion of the oil territory which has been lately developed.

The increased production has come chiefly from the Bushtenari, Campina, and Moreni fields. Drilling processes suitable to the peculiar geologic conditions have also been developed with great ingenuity, especially by Mr. Raki, and to this feature much credit is due for recent increased production.

*Production.*—In the following table is given the production of Roumania, by districts and months, during the year 1907, in metric tons:

*Production of crude petroleum in Roumania in 1907, by districts and months, in metric tons.*[a]

| Month. | District Prahova. | | | | | Dimbovitza. | Buzeu. | Bacau. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Bustenari. | Campina-Polana. | Moreni. | Other. | Total. | | | | |
| January | 44,463 | 10,883 | 19,050 | 3,725 | 78,121 | 2,524 | 770 | 707 | 82,122 |
| February | 40,042 | 22,394 | 18,505 | 3,966 | 84,907 | 2,731 | 697 | 685 | 89,020 |
| March | 42,372 | 21,625 | 22,828 | 7,293 | 94,118 | 2,950 | 850 | 700 | 98,618 |
| April | 39,693 | 20,802 | 23,373 | 7,406 | 91,274 | 2,675 | 762 | 676 | 95,387 |
| May | 40,874 | 19,363 | 29,898 | 7,466 | 97,601 | 2,826 | 775 | 647 | 101,849 |
| June | 38,885 | 16,452 | 26,367 | 7,429 | 89,133 | 2,509 | 755 | 671 | 93,068 |
| July | 42,250 | 18,096 | 23,936 | 7,700 | 91,982 | 2,402 | 1,141 | 787 | 96,312 |
| August | 41,347 | 18,310 | 27,096 | 6,562 | 93,315 | 2,647 | 865 | 812 | 97,639 |
| September | 39,313 | 20,905 | 25,495 | 6,524 | 92,237 | 2,507 | 932 | 889 | 96,565 |
| October | 38,452 | 21,656 | 28,512 | 5,858 | 94,478 | 3,212 | 920 | 841 | 99,451 |
| November | 35,541 | 18,051 | 23,377 | 6,029 | 82,998 | 2,834 | 756 | 882 | 87,470 |
| December | 36,222 | 21,597 | 23,710 | 5,978 | 87,507 | 2,497 | 704 | 888 | 91,596 |
| Total | 479,454 | 230,134 | 292,147 | 75,936 | 1,077,671 | 32,314 | 9,927 | 9,185 | 1,129,097 |

[a] 1 metric ton = 7.19 barrels of 42 gallons.

The production of crude petroleum in Roumania in the last six years has been as follows:

*Production of crude petroleum in Roumania, 1902-1907.*

| | Barrels. | | Barrels. |
|---|---|---|---|
| 1902 | 2,059,935 | 1905 | 4,420,987 |
| 1903 | 2,763,117 | 1906 | 6,378,184 |
| 1904 | 3,599,026 | 1907 | 8,118,207 |

The following table shows the progress made in every branch of the Roumanian petroleum industry during the last three years:

*Roumanian petroleum industry, 1905-1907.*

[Metric tons.]

| | 1905. | 1906. | 1907. | Increase in 1907 against 1906. |
|---|---|---|---|---|
| | | | | *Per cent.* |
| Crude-oil production | 614,870 | 887,091 | 1,129,097 | 27.5 |
| Crude oil treated at refineries | 510,143 | 748,798 | 950,614 | 27.0 |
| Output of refineries: | | | | |
| Benzine | 78,182 | 114,428 | 146,263 | 27.9 |
| Illuminating oil | 153,499 | 221,683 | 261,684 | 18.0 |
| Lubricating oils | 17,255 | 53,588 | 57,337 | 7.0 |
| Residuals | 237,677 | 333,714 | 452,685 | 35.6 |
| Home consumption: | | | | |
| Benzine | 615 | 566 | 85,564 | 20.3 |
| Illuminating oil | 31,558 | 35,243 | 38,467 | 9.1 |
| Lubricating oil | 4,921 | 5,350 | 5,851 | 9.3 |
| Residuals | 162,243 | 237,477 | 332,999 | 40.2 |
| Exports: | | | | |
| Benzine | 46,696 | 71,114 | 85,564 | 20.3 |
| Illuminating oil and distillate | 118,134 | 196,631 | 260,295 | 32.4 |
| Crude, residuals, etc | 49,515 | 53,374 | 77,779 | 45.7 |
| Stocks on Dec. 31: | | | | |
| Benzine | 20,084 | 18,275 | 47,506 | 160.0 |
| Illuminating oil | 30,144 | 48,967 | 36,128 | Decrease. |
| Lubricating oil and residuals | 64,452 | 67,334 | 67,816 | .7 |

These figures indicate steady and continuous progress in every branch of the industry, which shows that the industry rests on solid foundations.

The percentage of yield of various products from the crude oil in 1907 against 1906 was:

*Percentage of yield of various products from crude oil in 1906 and 1907.*

| | 1906. | 1907 |
|---|---|---|
| Benzine | 15.3 | 15.4 |
| Illuminating oil | 29.6 | 27.5 |
| Lubricating oils | 7.2 | 6.4 |
| Residuals | 44.5 | 47.2 |
| Total products | 96.6 | 96.5 |
| Loss in distilling and refining | 3.4 | 3.5 |

*Well record.*—The well record in Roumania in 1906 and 1907 is shown in the following table:

*Well record in Roumania at close of 1906 and 1907, by districts.*

| District. | December 31, 1906. | | | | | | December 31, 1907. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boreholes. | | | Handwells. | | | Boreholes. | | | Handwells. | | |
| | Producing. | Drilling. | Abandoned. | Producing. | Sinking. | Abandoned. | Producing. | Drilling. | Abandoned. | Producing. | Sinking. | Abandoned. |
| Prahova | 397 | 222 | 187 | 188 | 108 | 522 | 529 | 259 | 233 | 163 | 68 | 506 |
| Dambovitza | 14 | 9 | 16 | 107 | 16 | 98 | 12 | 8 | 18 | 101 | 16 | 98 |
| Buzeu | 8 | 4 | 11 | 71 | 15 | 36 | ...... | 4 | 19 | 63 | 2 | 57 |
| Bacau | 41 | 23 | 41 | 322 | 27 | 390 | 54 | 25 | 55 | 316 | 26 | 416 |
| Total | 460 | 258 | 255 | 688 | 166 | 1,046 | 595 | 296 | 325 | 643 | 112 | 1,077 |

### GERMANY.

The oil field in Hanover showed a significant increase after several years of slow decline. The gain was due to much higher prices with the increased demand from new refineries, and also to the necessity of giving employment to men formerly employed in the small potash industry near Hanover, which is now declining.

In the following table is shown the quantity and value of petroleum produced in the German Empire, by States, from 1901 to 1907, inclusive:

*Production and value of petroleum in the German Empire, 1901–1907, by States.*

| Year. | Alsace-Lorraine. | Prussia and Bavaria. | Total. | | Total value. | |
|---|---|---|---|---|---|---|
| | Quantity. | Quantity. | Quantity. | | | |
| | *Metric tons.* | *Metrictons.* | *Metrictons.* | *Barrels (42 gallons).* | *Marks.* | *Dollars.* |
| 1901 | 19,997 | 24,098 | 44,095 | 313,630 | 2,950,478 | 702,213 |
| 1902 | 20,205 | 29,520 | 49,725 | 353,674 | 3,351,000 | 797,538 |
| 1903 | 20,947 | 41,733 | 62,680 | 445,818 | 4,334,000 | 1,031,492 |
| 1904 | 22,016 | 67,604 | 89,620 | 637,431 | 5,805,000 | 1,381,590 |
| 1905 | 21,128 | 57,741 | 78,869 | 560,963 | 5,207,000 | 1,239,266 |
| 1906 | [a] 22,154 | 59,196 | 81,350 | 578,610 | 5,036,000 | 1,198,568 |
| 1907 | [a] 26,124 | 80,255 | 106,379 | 756,631 | 7,056,000 | 1,679,328 |

[a] Includes Bavaria.

1 metric ton, crude=7.1126 barrels.

### ITALY.

Much interest has been shown lately in the Italian oil fields. Italy has three small oil districts. The largest is in Emilia—in Parma and Piacenza. The second is in the Livi Valley, in Chieti, and the third is in Sicily. Consumption of lamp oils in Italy is retarded by excessive duties which the Government will reduce in 1908.

In the following tables will be found the production of crude petroleum in Italy from 1901 to 1906, with the value per unit and the total value. These tables are taken from the volumes of Rivista del Servizio Minerario.

*Production of crude petroleum in Italy, 1901–1906.*

| Year. | Number of wells in operation. | Quantity. | | Value. | |
|---|---|---|---|---|---|
| | | Metric tons. | United States barrels. | Lire. | Dollars. |
| 1901 | 9 | 2,246 | 16,150 | 671,065 | 129,515 |
| 1902 | 9 | 2,633 | 18,933 | 778,163 | 150,185 |
| 1903 | 10 | 2,486 | 17,876 | 737,293 | 142,298 |
| 1904 | 10 | 3,543 | 25,476 | 1,053,294 | 203,286 |
| 1905 | 9 | 6,123 | 44,027 | 1,826,802 | 352,573 |
| 1906 | 12 | 7,451 | 53,577 | 2,226,559 | 429,726 |

1 metric ton, crude=7.1905 barrels.

## GREAT BRITAIN.

*Oil shale.*—In the following table is shown the production of oil shale in Great Britain in 1906 and 1907, taken from the Mineral Statistics of the United Kingdom:

*Quantity and value of oil shale in Great Britain, 1906–1907, in long tons.*

| Country. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| England | | | | |
| Scotland | 2,545,724 | £657,649 | 2,675,779 | (a) |
| Wales | 798 | 279 | | |
| Total | 2,546,522 | 657,928 | 2,675,779 | (a) |

a Not available.

The oil shale industry of Scotland is of considerable importance. During the year 1907 a total of 2,675,779 tons was produced, as against 2,545,724 tons in 1906. The mineral is obtained chiefly in Edinburghshire and Linlithgowshire from seams in the calciferous sandstone at the base of the Carboniferous rocks. The average yield of oil is 23 gallons per ton of shale. Some of the seams worked are rich in oil and poor in sulphate of ammonia; in others, the reverse is the case. No oil shale was produced in England, Ireland, or Wales in the years 1906 and 1907.

In the year 1906, 10 long tons of petroleum were produced in Dumbartonshire, Scotland, valued at £15. No petroleum was produced in Great Britain in the year 1907.

The imports of refined petroleum from the United States to the United Kingdom in the year ending June 30, 1907, were 231,692,636 gallons, valued at $14,245,310, as compared with 249,517,345 gallons in 1906, valued at $15,533,606.

The following statement regarding imports of petroleum to the United Kingdom has been kindly furnished by the British Board of Trade.

The imports of petroleum and its products to the United Kingdom during the years 1906 and 1907 were as follows:

*Imports of petroleum to the United Kingdom in 1906 and 1907, in gallons.*

| Description. | 1906. | 1907.[a] |
|---|---|---|
| Lubricating oils | 49,704,819 | 49,529,960 |
| Lamp oils | 151,239,979 | 150,611,230 |
| Crude | 1,112,710 | |
| Spirit | 26,792,684 | 33,536,739 |
| Gas oil | 56,551,321 | 61,719,374 |
| Fuel oil | 13,819,091 | 8,737,179 |

a Subject to revision.

## INDIA.

The following table gives the production of petroleum in India from 1902 to 1907 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

*Production and value of petroleum in India, 1902-1907.*

| Year. | Quantity. | | Value. | |
|---|---|---|---|---|
| | Imperial gallons. | Barrels (42 United States gallons). | Rupees.[a] | Dollars. |
| 1902 | 56,607,688 | 1,617,363 | 3,267,245 | 1,058,587 |
| 1903 | 87,859,069 | 2,510,259 | 5,315,470 | 1,722,212 |
| 1904 | 118,491,382 | 3,385,468 | 7,109,566 | 2,303,499 |
| 1905 | 144,798,444 | 4,137,098 | 9,065,051 | 2,936,429 |
| 1906 | 140,553,122 | 4,015,803 | 8,613,576 | 2,790,799 |
| 1907 | 152,045,677 | 4,344,162 | 9,150,225 | 2,968,637 |

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

*Production of crude petroleum in India, 1904-1907, by provinces.*

| Province. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| | *Gallons.* | *Gallons.* | *Gallons.* | *Gallons.* |
| Burma | 115,903,804 | 142,063,846 | 137,654,261 | 148,888,002 |
| Eastern Bengal and Assam | 2,585,920 | 2,733,110 | 2,897,990 | 3,156,665 |
| Punjab | 1,658 | 1,488 | 871 | 1,010 |
| Total | 118,491,382 | 144,798,444 | 140,553,122 | 152,045,677 |

## DUTCH EAST INDIES.

In the following table is given the production of crude petroleum in the Dutch East Indies during the years 1903 to 1907, inclusive:

*Production of crude petroleum in Dutch East Indies, 1903-1907.*

| Year. | Metric tons. | Liters. | Barrels. |
|---|---|---|---|
| 1903 | 780,985 | 920,422,000 | 5,789,364 |
| 1904 | 1,036,304 | 1,221,325,000 | 7,682,014 |
| 1905 | 1,158,360 | 1,365,173,000 | 8,586,804 |
| 1906 | 1,168,581 | 1,377,219,000 | 8,662,572 |
| 1907 [a] | 1,178,797 | 1,389,259,000 | 8,738,302 |

[a] Estimated 1 United States barrel = 158.985 liters; 1 liter = 1.0567 quarts.

Of the total production in 1907 it is estimated that Java produced 135,520 tons, or 993,507 barrels; Sumatra, 404,832 tons, or 3,150,000 barrels; and Borneo, 638,445 tons, or 4,594,795 barrels.

## JAPAN.

In the following table is given the production of petroleum in Japan from 1903 to 1907, inclusive:

*Production of petroleum in Japan, 1903–1907.*[a]

[Barrels of 42 gallons.]

| Year. | Crude. | | Refined. | |
|---|---|---|---|---|
| | *Koku.* | *Barrels.* | *Koku.* | *Barrels.* |
| 1903 | 1,065,116 | 1,209,971 | 333,346 | 378,681 |
| 1904 | 1,249,536 | 1,419,473 | | |
| 1905[a] | 1,296,482 | 1,472,804 | ........... | ........... |
| 1906 | 1,501,563 | 1,705,776 | 582,138 | 661,309 |
| 1907 | 1,755,464 | 1,994,207 | 655,420 | 744,557 |

[a] Excluding the Island of Formosa.

1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

In the following table is given a statement of the production of crude petroleum in Japan in 1905, 1906, and 1907, by fields:

*Production of crude petroleum in Japan, 1905–1907, by fields.*

| Field. | 1905. | 1906. | 1907. |
|---|---|---|---|
| | *Koku.* | *Koku.* | *Koku.* |
| Echigo: | | | |
| Higashiyama | 273,844 | 304,847 | 342,042 |
| Nishiyama | 271,495 | 294,277 | 360,115 |
| Niitsu | 634,704 | 808,655 | 970,556 |
| Kubiki | 97,075 | 76,578 | 63,572 |
| Amaze | 5,220 | 7,262 | 12,447 |
| Ojiya | 14,180 | 9,964 | 6,732 |
| Total | 1,296,482 | 1,501,563 | 1,755,464 |

*Production of crude petroleum in Japan and Formosa in 1906–7.*

| Year. | Japan. | | Formosa. | | Total. | |
|---|---|---|---|---|---|---|
| | *Koku.* | *Barrels.* | *Koku.* | *Barrels.* | *Koku.* | *Barrels.* |
| 1906 | 1,501,563 | 1,705,776 | 4,394 | 4,992 | 1,505,957 | 1,710,768 |
| 1907 | 1,755,464 | 1,994,207 | [a]14,465 | 16,432 | 1,769,929 | 2,010,639 |

[a] Estimated.

*Production of refined petroleum in Japan and Formosa in 1906–7.*

| Year. | Japan. | | Formosa. | | Total. | |
|---|---|---|---|---|---|---|
| | *Koku.* | *Barrels.* | *Koku.* | *Barrels.* | *Koku.* | *Barrels.* |
| 1906 | 582,138 | 661,309 | [a]3,515 | 3,993 | 585,653 | 665,302 |
| 1907 | 655,420 | 744,557 | [a]11,572 | 13,146 | 666,992 | 757,703 |

[a] Estimated.

*Consumption of kerosene in Japan, 1904–1907.*

| Year. | Domestic. | Imported. | Total. | |
|---|---|---|---|---|
| | *Koku.* | *Koku* | *Koku.* | *Barrels.* |
| 1904 | 562,143 | 2,041,295 | 2,603,438 | 2,957,506 |
| 1905 | 596,580 | 1,467,582 | 2,064,162 | 2,344,888 |
| 1906 | 686,483 | 1,485,725 | 2,172,208 | 2,467,628 |
| 1907 [a] | 389,126 | 671,102 | 1,060,228 | 1,204,419 |

[a] First six months.

The total importation of petroleum to Japan in 1907 was 70,165,626 American gallons, as compared with 59,429,008 gallons in 1906.

## WORLD'S PRODUCTION.

*World's production of crude petroleum, 1903–1907, by countries.*

[Barrels of 42 gallons.]

| Country. | 1903. | 1904. | 1905. | 1906. | 1907. | | Percentage of total production. |
|---|---|---|---|---|---|---|---|
| | | | | | *Barrels.* | *Metrictons.* | |
| United States | 100,461,337 | 117,080,960 | 134,717,580 | 126,493,936 | 166,095,335 | 22,149,862 | 63.12 |
| Russia | 75,591,256 | 78,536,655 | 54,960,270 | 58,897,311 | 61,850,734 | 8,247,795 | 23.50 |
| Sumatra, Java, and Borneo | 5,789,364 | 7,682,014 | 8,586,804 | 8,662,572 | [a] 8,738,302 | 1,178,797 | 3.36 |
| Galicia | 5,234,475 | 5,947,383 | 5,765,317 | 5,467,967 | 8,360,441 | 1,175,974 | 3.36 |
| Roumania | 2,763,117 | 3,599,026 | 4,420,987 | 6,378,184 | 8,118,207 | 1,129,097 | 3.22 |
| India | 2,510,250 | 3,385,468 | 4,137,098 | 4,015,803 | 4,344,162 | 579,316 | 1.65 |
| Japan | 1,209,371 | 1,418,767 | 1,341,157 | 1,710,768 | 2,010,639 | 268,129 | .76 |
| Mexico | | | | | 1,000,000 | 138,855 | .38 |
| Canada | 486,637 | 552,575 | 634,095 | 569,753 | 788,872 | 105,200 | .30 |
| Germany | 445,818 | 637,431 | 560,963 | 578,610 | 756,631 | 106,379 | .30 |
| Peru | 49,048 | 49,524 | 37,720 | 42,419 | 65,476 | 8,732 | .02 |
| Italy | 17,876 | 25,476 | 44,027 | 53,577 | [a] 53,500 | 7,450 | .02 |
| Other | [a] 30,000 | [a] 40,000 | [a] 30,000 | [a] 30,000 | [a] 30,000 | 4,000 | .01 |
| Total | 194,588,558 | 218,955,270 | 215,236,018 | 212,900,900 | 262,212,269 | 35,094,086 | 100.00 |

[a] Estimated.

## FRACTIONATION OF CRUDE PETROLEUM BY CAPILLARY FILTRATION.

The writer has previously shown [a] that when petroleum filters through dry, finely divided clay or shale, it is separated into different fractions in a way comparable to distillation. This investigation has been carried further during the last year by Dr. J. Elliott Gilpin and Dr. Marshall P. Cram at the Johns Hopkins University, Baltimore, with the aid of the United States Geological Survey, and under the supervision of the writer.

Florida fuller's earth, ground and passed through 150 meshes to the inch, was heated until perfectly dry, and packed in glass or tin tubes 5½ feet long by 1½ inches in diameter. The ends of these tubes were placed in jars, each containing 950 c. c. of petroleum from Third sand, Venango County, Pa., with specific gravity of 0.810. It was found that, in the course of a week or more, the oil would rise by capillary diffusion to the top of such tube, but by exhausting the air from the tube, the same effect could be produced in 17 hours. The effort was also made to hasten the diffusion by heating the oil, and also by diffusing it into the earth under heavy pressure. Neither of them, however, showed any appreciable difference in the rate of diffusion. The earth containing the oil was removed in sections from the tube, and each section was treated first with a small quantity of water, then with additional quantities. It was found that the oil thus obtained differed in color, the highest in the tubes being colorless, and differed also in specific gravity, a sample result being shown in the following table:

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[a] Phila. Academy of Science, 1897, and Transactions of the First International Petroleum Congress, Paris, 1900.

*Diffusion of crude petroleum through fuller's earth.*

| | 1. | | 2. | | 3. | |
|---|---|---|---|---|---|---|
| Time required........hours.. | 23.5 | | 17.5 | | 17.5 | |
| Distance from top of tube to oil when opened, centimeters...................... | 31 | | 28 | | 28 | |
| | *Specific gravity.* | *Cubic centimeters.* | *Specific gravity.* | *Cubic centimeters.* | *Specific gravity.* | *Cubic centimeters.* |
| A, 8 centimeters at top....... | 0.796 | 42 | 0.8012 | 30 | 0.8022 | 18 |
| B, next 8 centimeters ........ | .808 | 45 | .804 | 37 | .803 | 35 |
| C, next 18 centimeters......... | .8125 | 75 | .807 | 47 | .8075 | 66 |
| | .8137 | 24 | .809 | 22 | .810 | 25 |
| D, next 30 centimeters ....... | .815 | 130 | .8125 | 148 | .812 | 140 |
| E, next 35 centimeters ....... | .818 | 170 | .8165 | 190 | .8175 | 145 |
| F, rest........................ | .8205 | 125 | .823 | 100 | .821 | 105 |
| Total.................. | ............ | 611 | ............ | 574 | ............ | 534 |

Fractionations resulting from a large number of tubes were united and those of the same specific gravity fractionated again, and the final products were examined by distillation and by treatment with sulphuric acid. It was noted that about one-third of the oil remained in the fuller's earth and could not be removed by water. Pressure of 200 pounds to the square inch on this fuller's earth, from which all possible oil had been washed, pressed out considerable water, but very little oil. Distillation of this earth and extraction with ether, yielded oil in appearance about like the original petroleum used. A clay from Topsham, Me., showed similar fractionating power, but powdered brick made from the same clay, and powdered feldspar, both showed no power of fractionation whatever.

Summarizing the results of the investigation, the following has already been demonstrated:

1. When petroleum is allowed to rise in a tube packed with fuller's earth, there is a decided fractionation of the oil, the fraction at the top of the tube being of lower specific gravity than that at the bottom.
2. When water is added to fuller's earth which contains petroleum, the oil which is displaced first differs in specific gravity from that which is displaced afterwards when more water is added.
3. When petroleum is allowed to rise in a tube packed with fuller's earth, the paraffin hydrocarbons tend to collect in the lightest fraction at the top of the tube and the unsaturated hydrocarbons at the bottom.
4. Whenever oil is mixed with fuller's earth and then displaced with water, about one-third of the oil remains in the earth.

The investigation will be continued.

# THE CEMENT INDUSTRY IN THE UNITED STATES IN 1907.

By Edwin C. Eckel.

## ACKNOWLEDGMENTS.

The data on cement production which form the basis of the following report are collected directly by the United States Geological Survey, requests for statistics being sent to every producing cement plant in the country. It is a pleasure to acknowledge the promptness and completeness with which these statistical inquiries are answered. For some years past returns have been received from every producing plant, so that the Survey's cement statistics have covered the industry completely. In this connection acknowledment must be made of the services of Mrs. L. L. Kimball, of the Survey, who since 1902 has had charge of the receipt, comparison, and tabulation of the individual reports.

## PRODUCTION.

Before taking up the statistics relative to the three kinds of cement separately, it is of interest to summarize the facts relative to the total cement production of the United States in 1907.

The total quantity of Portland, natural, and puzzolan cements produced in the United States during 1907 was 52,230,342 barrels, valued at $55,903,851. As compared with the production of 1906, which was 51,000,445 barrels, valued at $55,302,277, an increase of 2.4 per cent in quantity and of 1.1 per cent in value is shown. This increase is the smallest recorded in recent years.

The distribution of the total among the three main classes of cement is indicated in the following table:

*Total production of cement in the United States in 1906 and 1907, by classes.*

| Class. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity (barrels). | Value. | Quantity (barrels). | Value. |
| Portland | 46,463,424 | $52,466,186 | 48,785,390 | $53,992,551 |
| Natural | 4,055,797 | 2,423,170 | 2,887,700 | 1,467,302 |
| Puzzolan | 481,224 | 412,921 | 557,252 | 443,998 |
| Total | 51,000,445 | 55,302,277 | 52,230,342 | 55,903,851 |

## PORTLAND CEMENT.

### STATISTICS OF PRODUCTION.

### PRODUCTION BY STATES.

The total Portland cement production of the United States in 1907 was 48,785,390 barrels, valued at $53,992,551, an increase over the output of 1906 of 2,321,966 barrels, or about 5 per cent, in quantity, and of $1,526,365, or about 3 per cent, in value. The distribution of this total among the different producing States in 1907 is given in the following table. The production by States for 1906 is included for comparison:

*Production of Portland cement in the United States in 1906 and 1907, by States.*

| 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|
| State. | Producing plants. | Quantity (barrels). | Value. | State. | Producing plants. | Quantity (barrels). | Value. |
| Illinois | 4 | 1,858,403 | $2,461,494 | Illinois | 5 | 2,036,093 | $2,632,576 |
| Indiana | 6 | 3,951,836 | 4,964,855 | Indiana | 7 | 3,782,841 | 4,757,860 |
| Kansas | 4 | 3,020,862 | 3,968,708 | Kansas | 5 | 3,353,925 | 4,240,358 |
| Michigan | 14 | 3,747,525 | 4,814,965 | Michigan | 14 | 3,572,668 | 4,384,731 |
| New Jersey | 3 | 4,423,648 | 4,445,364 | New Jersey | 3 | 4,449,896 | 4,738,516 |
| New York | 9 | 2,414,362 | 2,725,744 | New York | 9 | 2,290,955 | 2,433,918 |
| Ohio | 8 | 1,422,901 | 1,709,918 | Ohio | 9 | 1,151,176 | 1,377,155 |
| Pennsylvania | 19 | 18,645,015 | 18,598,439 | Pennsylvania | 22 | 20,393,965 | 19,698,006 |
| Alabama | 1 | 1,172,041 | 1,432,023 | Alabama | 2 | 1,274,470 | 1,383,305 |
| Georgia | 1 | | | Georgia | 1 | | |
| Virginia | 1 | | | Virginia | 1 | | |
| West Virginia | 1 | | | West Virginia | 1 | | |
| Arizona | 1 | 1,146,396 | 2,034,382 | Arizona | 1 | 534,534 | 915,301 |
| Colorado | 1 | | | South Dakota | 1 | | |
| South Dakota | 1 | | | Texas | 2 | | |
| Texas | 2 | | | California | 4 | 1,893,004 | 2,715,398 |
| Utah | 1 | | | Washington | 1 | | |
| California | 3 | 1,310,435 | 2,110,294 | Colorado | 1 | 864,938 | 1,395,179 |
| Washington | 1 | | | Utah | 2 | | |
| Kentucky | 1 | 3,350,000 | 3,200,000 | Kentucky | 1 | 3,186,925 | 3,320,248 |
| Missouri | 2 | | | Missouri | 2 | | |
| Total | 84 | 46,463,424 | 52,466,186 | Total | 94 | 48,785,390 | 53,992,551 |

In the foregoing table, the outputs of States having only one or two active plants are combined, so as to prevent publication of individual figures. In 1907, for example, the following combinations are made: Alabama, Georgia, Virginia, and West Virginia; Kentucky and Missouri; Colorado and Utah; Texas, Arizona, and South Dakota; California and Washington.

### RANK OF PRODUCING STATES.

The rank of the Portland-cement producing States has shown little change in the last two years. Pennsylvania is still the leading State by a large margin; New Jersey is second; Indiana third, Michigan fourth, and Kansas fifth. None of the remaining States produced as much as 3,000,000 barrels during the year, and the five States named contribute almost three-fourths of the total production.

Some of the changes in this respect which have taken place since 1890 are indicated in the following table:

*Development of the Portland-cement industry in the United States since 1890.*

| Section. | 1890. | | | 1900. | | |
|---|---|---|---|---|---|---|
| | Number of works. | Quantity (barrels). | Percentage. | Number of works. | Quantity (barrels). | Percentage. |
| New York | 4 | 65,000 | 19.4 | 8 | 465,832 | 5.5 |
| Lehigh and Northampton counties, Pa., and Warren County, N. J | 5 | 201,000 | 59.9 | 15 | 6,153,629 | 72.6 |
| Ohio | 2 | 22,000 | 6.5 | 6 | 534,215 | 6.3 |
| Michigan | ........ | ........ | ........ | 6 | 664,750 | 7.8 |
| All other sections | 5 | 47,500 | 14.2 | 15 | 663,504 | 7.8 |
| Total | 16 | 335,500 | 100.0 | 50 | 8,482,020 | 100.0 |

| Section. | 1905. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Number of works. | Quantity (barrels). | Percentage. | Number of works. | Quantity (barrels). | Percen t age. |
| New York | 11 | 2,111,411 | 6.0 | 9 | 2,290,955 | 4.7 |
| Lehigh and Northampton counties, Pa. | 15 | 13,713,910 | 38.9 | 18 | 19,967,790 | 40.9 |
| New Jersey | 3 | 3,654,777 | 10.4 | 3 | 4,449,896 | 9.1 |
| Ohio | 8 | 1,312,977 | 3.7 | 9 | 1,151,176 | 2.4 |
| Michigan | 16 | 2,773,283 | 7.9 | 14 | 3,572,668 | 7.3 |
| All other sections | 36 | 11,680,454 | 33.1 | 41 | 17,352,905 | 35.6 |
| Total | 89 | 35,246,812 | 100.0 | 94 | 48,785,390 | 100.0 |

## PRODUCTION BY DISTRICTS.

The Portland-cement industry exhibits the same tendency toward geographic centralization, though to a less degree, that has given Pittsburg its preeminence as an iron producer. In the case of the Portland-cement industry the concentration of plants is in the so-called Lehigh district of Pennsylvania, with its New Jersey continuation. Here, 21 plants made over 24,400,000 barrels, or slightly over half of all the Portland cement produced in the United States in 1907. The Lehigh district was the point where American Portland-cement manufacture was first undertaken, and it owes its continued preeminence to the possession of good raw materials, good labor, good and fairly cheap fuel, and excellent transportation facilities to large eastern markets.

Taking a general view of the matter, the present geographic distribution of the cement industry is well shown in the following table. The term "East,"as here used, includes plants in Pennsylvania, New York, and New Jersey, none being located in New England. The "Central" plants are those in Ohio, Indiana, Illinois, Michigan, and Missouri. Under "West" are included Kansas, Colorado, South Dakota, Arizona, and Utah. On the Pacific coast are the four active California plants and one recently started in Washington. The "South" includes Virginia, West Virginia, Georgia, Alabama, Arkansas, Texas, and Kentucky.

*Geographic distribution of Portland-cement industry, 1905–1907.*

| | Plants in operation. | | | Output, in barrels. | | | Percentage of total output. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1905. | 1906. | 1907. | 1905. | 1906. | 1907. | 1905. | 1906. | 1907. |
| East | 30 | 31 | 34 | 19,589,675 | 25,483,025 | 27,134,816 | 55.6 | 54.9 | 55.6 |
| Central | 32 | 34 | 37 | 10,723,802 | 14,030,665 | 13,479,703 | 30.4 | 30.2 | 27.6 |
| West | 7 | 8 | 10 | 2,470,349 | 3,834,656 | 4,463,397 | 7.0 | 8.2 | 9.2 |
| Pacific coast | 3 | 4 | 5 | 1,225,429 | 1,310,435 | 1,893,004 | 3.5 | 2.8 | 3.9 |
| South | 7 | 7 | 8 | 1,237,557 | 1,804,643 | 1,814,470 | 3.5 | 3.9 | 3.7 |
| Total | 79 | 84 | 94 | 35,246,812 | 46,463,424 | 48,785,390 | 100.0 | 100.0 | 100.0 |

## RAW MATERIALS.

### RAW MATERIALS USED IN MANUFACTURE OF PORTLAND CEMENT.

Numerous requests reach the Geological Survey for information concerning the raw materials used in the Portland-cement industry. As the new edition of Bulletin 243,[a] which discusses this subject in considerable detail, will not be ready for publication for some time, it has been thought desirable to present in this statistical report a summary of the more important facts relative to raw materials.

Portland cement is produced by burning a finely ground artificial mixture consisting essentially of lime, silica, alumina, and iron oxide, in certain definite proportions. Usually this combination is made by mixing limestone or marl with clay or shale, in which case about three times as much of the lime carbonate should be present in the mixture as of the clayey materials. The burning takes place at a high temperature, approaching 3,000° F., and must therefore be carried on in kilns of special design and lining. During the burning, combination of the lime with silica, alumina, and iron oxide takes place. The product of the burning is a semifused mass called clinker, and consists of silicates, aluminates, and ferrites of lime in certain definite proportions. This clinker must be finely ground. After such grinding, the resulting powder is Portland cement.

The finished product is blue to gray in color, has a specific gravity of 3 to 3.25, and when mixed with water will harden or set.

The product must be uniform in composition and quality; and as the processes of manufacture involve certain chemical as well as physical changes, four points may be regarded as of cardinal importance in making Portland cement. These are:

1. The cement mixture must be of the proper chemical and physical composition;
2. The raw materials of which it is composed must be finely ground and intimately mixed before burning;
3. The burning must be conducted at the proper temperature;
4. After burning the resulting clinker must be finely ground.

In the present report only such matters as directly concern the question of raw materials will be discussed, as questions relating to processes of manufacture do not fall within the field of work of the Geological Survey. For present purposes it will be sufficiently accurate to consider that a Portland-cement mixture, when ready for burning, will consist of about 75 per cent of lime carbonate ($CaCO_3$) and 20 per cent of silica ($SiO_2$), alumina ($Al_2O_3$) and iron oxide ($Fe_2O_3$) together, the remaining 5 per cent including any magnesium carbonate, sulphur, and alkalies that may be present.

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[a] Eckel, E. C., Cement materials and industry of the United States, Bull. U. S. Geol. Survey No. 243, 1905.

The essential elements which enter into this mixture—lime, silica, alumina, and iron—are all abundantly and widely distributed in nature, occurring in different forms in many kinds of rocks. It can therefore be readily seen that, theoretically, a satisfactory Portland-cement mixture could be prepared by combining, in an almost indefinite number of ways and proportions, many possible raw materials. Obviously, too, we might expect to find perfect gradations in the artificialness of the mixture, varying from the one extreme where a natural rock of absolutely correct composition was used, to the other extreme where two or more materials, in nearly equal amounts, are required to make a mixture of correct composition.

The almost infinite number of raw materials which are theoretically available are, however, reduced to a very few in practice under existing commercial conditions. The necessity for making the mixture as cheaply as possible rules out of consideration a large number of materials which would be considered available if chemical composition was the only thing to be taken into account. Some materials otherwise suitable are too scarce; some are too difficult to pulverize to the fineness necessary to bring about the requisite chemical combination of the mixture in the kiln. In consequence, a comparatively few combinations of raw materials are actually used in practice.

In certain localities deposits of argillaceous (clayey) limestone or "cement rock" occur, in which the lime, silica, alumina, and iron oxide exist in so nearly the proper proportions that only a relatively small amount (say 10 per cent or so) of other material is required in order to make a mixture of correct composition.

In the majority of plants, however, most or all of the necessary lime is furnished by one raw material, while the silica, alumina, and iron oxide are largely or entirely derived from another raw material. The raw material which furnishes the lime is limestone, chalk, or marl, while the silica, alumina, and iron oxide of the mixture are derived from clay, shale, or slate.

## PRODUCTION ACCORDING TO RAW MATERIALS USED.

In the following table the production of Portland cement in the United States is classified according to the kinds of raw materials from which the cement was manufactured.

The production is grouped as follows:

Type 1 includes cement produced from a mixture of argillaceous limestone ("cement rock") and pure limestone. This is the combination of materials used in all the cement plants of the Lehigh district of Pennsylvania and New Jersey, and also at several western plants.

Type 2 includes cement made from a mixture of comparatively pure limestone with clay or shale. This mixture is employed at many plants all over the United States.

Type 3 includes cement manufactured from a mixture of marl and clay. This type of mixture is used only in the States of Michigan, Ohio, Indiana, and New York.

Type 4 includes Portland cement manufactured from a mixture of limestone and blast-furnace slag.

*Production, in barrels, and percentage of total output of Portland cement in the United States according to type of material used, 1898–1907.*

| Year. | Type 1. Argillaceous limestone (cement rock) and pure limestone. | | Type 2. Limestone and clay or shale. | | Tpye 3. Marl and clay. | | Type 4 Slag and limestone. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. | Percentage. |
| 1898 | 2,764,694 | 74.9 | 365,408 | 9.9 | 562,092 | 15.2 | ........ | ........ |
| 1899 | 4,010,132 | 70.9 | 546,200 | 9.7 | 1,095,934 | 19.4 | ........ | ........ |
| 1900 | 5,960,739 | 70.3 | 1,034,041 | 12.2 | 1,454,797 | 17.1 | 32,443 | 0.4 |
| 1901 | 8,503,500 | 66.9 | 2,042,209 | 16.1 | 2,001,200 | 15.7 | 164,316 | 1.3 |
| 1902 | 10,953,178 | 63.6 | 3,738,303 | 21.7 | 2,220,453 | 12.9 | 318,710 | 1.8 |
| 1903 | 12,493,694 | 55.9 | 6,333,403 | 28.3 | 3,052,946 | 13.7 | 462,930 | 2.1 |
| 1904 | 15,173,391 | 57.2 | 7,526,323 | 28.4 | 3,332,873 | 12.6 | 473,294 | 1.8 |
| 1905 | 18,454,902 | 52.4 | 11,172,389 | 31.7 | 3,884,178 | 11.0 | 1,735,343 | 4.9 |
| 1906 | 23,896,951 | 51.4 | 16,532,212 | 35.6 | 3,958,201 | 8.5 | 2,076,000 | 4.5 |
| 1907 | 25,859,095 | 53.0 | 17,190,697 | 35.2 | 3,606,598 | 7.4 | 2,129,000 | 4.4 |

## VALUATION OF DEPOSITS OF CEMENT MATERIALS.

Very erroneous ideas appear to be current concerning the value of deposits of cement materials. It should be clearly understood that in most parts of the United States excellent cement materials are common, and that the commercial value of undeveloped deposits of such materials is necessarily slight. In most of the Eastern, Southern, and middle Western States there is no difficulty whatever in securing lands containing limestones suitable for cement manufacture at prices ranging from $5 to $50 per acre, and it is only exceptional circumstances which would allow any cement deposit to be valued at more than the latter price. As indicated below, the value of the deposit depends less upon the character of the materials than upon other factors.

The determination of the possible value for Portland cement manufacture of a deposit of raw material is a complex problem, depending upon a number of distinct factors, all of which must be given due consideration. The more important of the factors are:

1. Chemical composition of the material.
2. Physical character of the material.
3. Amount of material available.
4. Location of the deposit with respect to transportation routes.
5. Location of the deposit with relation to fuel supplies.
6. Location of the deposit with respect to markets.

Ignorance of the respective importance of these factors frequently leads to an overestimate of the value of a deposit of raw material.

The characteristics of a deposit necessary for the manufacture of a good Portland cement may be briefly stated as follows: The raw material must be of correct chemical composition for use as a cement material. This implies that the material, if a limestone, must contain as small a percentage as possible of magnesium carbonate. Under present conditions 5 or 6 per cent of magnesium carbonate is the maximum permissible. Free silica, in the form of chert, flint, or sand must be absent, or present only in small quantities, say 1 per cent or less. If the limestone is a clayey limestone or "cement rock," the proportion between its silica and its alumina and iron should fall within the limits

$$\frac{SiO_2}{Al_2O_3 + Fe_2O_3} > 2. \quad \text{and} \quad \frac{SiO_2}{Al_2O_3 + Fe_2O_3} < 3.5$$

A clay or shale should satisfy the above equation and should be free from sand, gravel, etc. Alkalies and sulphates should, if present, not exceed 3 per cent or so.

The nearer a limestone approaches in composition to the mixture used in Portland cement manufacture the greater its value for that purpose, for it will require the addition of less extraneous material to make the mixture absolutely correct in composition. The following are analyses of Portland-cement mixtures, ready for burning, as used at various large cement plants in the United States:

*Analyses of Portland cement mixtures.*

| | 1. | 2. | 3. | 4. |
|---|---|---|---|---|
| Silica ($SiO_2$) | 12.85 | 12.92 | 13.52 | 14.94 |
| Alumina ($Al_2O_3$) | 4.92 | 4.83 | 6.56 | 2.66 |
| Iron oxide ($Fe_2O_3$) | 1.21 | 1.77 | ........ | 1.10 |
| Lime carbonate ($CaCO_3$) | 76.36 | 75.53 | 75.13 | 75.59 |
| Magnesium carbonate ($MgCO_3$) | 2.13 | 4.34 | 4.32 | 4.64 |

It will be seen that the usual mixtures carry from 75 to 77 per cent of lime carbonate. Bearing this in mind, it will be obvious that there is a great advantage in using, as one of the raw materials, a limestone of about this degree of purity. If rock of this composition occurs in sufficient quantity, it would require but little admixture of other materials to keep the cement correct in composition.

## GEOGRAPHIC DISTRIBUTION OF CEMENT MATERIALS IN THE UNITED STATES.

It is of course impossible to discuss this subject within the limits permissible in this chapter, for any satisfactory treatment of it would require hundreds of pages, while the scope of the present report is necessarily restricted. Detailed descriptions of this character are contained in Bulletin 243 of the United States Geological Survey. This bulletin, which was published a few years ago, but was soon out of print, is now being rewritten and will be issued in an entirely revised form as soon as possible. In order to fill the requirements of the present report, an attempt has been made to summarize in the following schedule the main facts regarding the occurrence or nonoccurrence of the more important cement materials in the various States.

In this table four symbols are used to denote various degrees of abundance or rarity. A indicates the occurrence of large and widely distributed deposits; B indicates the occurrence either of a few large deposits or of a number of small ones; C indicates the occurrence of a few small deposits only; 0 indicates that the material is either absolutely wanting or is so scarce as not to be of any possible commercial importance.

In regard to the fuel supplies noted in the table, a word of caution is necessary. The term "coal" is here limited to such coals as can be used in cement manufacture with reasonable economy. Peat, lignite, and many western "coals" are therefore omitted from consideration.

*Occurrence of the more important cement materials, by States.*

| State. | Raw materials. | | | Fuels. | | | State. | Raw materials. | | | Fuels. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low-magnesia limestones. | Fresh-water marls. | Soft lime-stones. | Coal. | Oil. | Gas. | | Low-magnesia limestones. | Fresh-water marls. | Soft lime-stones. | Coal. | Oil. | Gas. |
| Alabama | A | 0 | A | A | 0 | C | Nebraska | B | 0 | B | 0 | 0 | 0 |
| Arizona | B | 0 | 0 | C | 0 | 0 | Nevada | B | 0 | 0 | 0 | 0 | 0 |
| Arkansas | A | 0 | B | A | 0 | 0 | New Hampshire | B | 0 | 0 | 0 | 0 | 0 |
| California | B | 0 | B | C | A | C | New Jersey | A | C | 0 | 0 | 0 | 0 |
| Colorado | A | 0 | A | B | A | 0 | New Mexico | B | 0 | 0 | C | 0 | 0 |
| Connecticut | C | 0 | 0 | 0 | 0 | 0 | New York | A | A | 0 | 0 | C | B |
| Delaware | C | 0 | 0 | 0 | 0 | 0 | North Carolina | C | 0 | A | C | 0 | 0 |
| Florida | A | 0 | A | 0 | 0 | 0 | North Dakota | 0 | 0 | C | 0 | 0 | 0 |
| Georgia | A | 0 | B | B | 0 | 0 | Ohio | A | A | 0 | A | A | A |
| Idaho | B | 0 | 0 | B | 0 | 0 | Oklahoma | A | 0 | B | A | A | A |
| Illinois | A | A | 0 | A | A | A | Oregon | C | 0 | 0 | C | 0 | 0 |
| Indiana | A | C | 0 | A | A | A | Pennsylvania | A | 0 | 0 | A | A | A |
| Iowa | A | 0 | 0 | A | 0 | 0 | Rhode Island | C | 0 | 0 | 0 | 0 | 0 |
| Kansas | A | 0 | C | A | A | A | South Carolina | C | 0 | B | 0 | 0 | 0 |
| Kentucky | A | 0 | 0 | A | A | A | South Dakota | 0 | 0 | B | 0 | 0 | 0 |
| Louisiana | 0 | 0 | C | 0 | B | 0 | Tennessee | A | 0 | 0 | A | C | C |
| Maine | B | 0 | 0 | 0 | 0 | 0 | Texas | A | 0 | A | C | A | A |
| Maryland | A | 0 | 0 | A | 0 | 0 | Utah | A | 0 | 0 | A | 0 | 0 |
| Massachusetts | C | C | 0 | 0 | 0 | 0 | Vermont | B | 0 | 0 | 0 | 0 | 0 |
| Michigan | A | A | 0 | A | 0 | 0 | Virginia | A | 0 | A | A | 0 | 0 |
| Minnesota | C | C | 0 | 0 | 0 | 0 | Washington | B | 0 | 0 | C | 0 | 0 |
| Mississippi | C | 0 | A | 0 | 0 | 0 | West Virginia | A | 0 | 0 | A | A | A |
| Missouri | A | 0 | 0 | A | 0 | 0 | Wisconsin | C | C | 0 | 0 | 0 | 0 |
| Montana | A | 0 | B | C | .... | .... | Wyoming | A | 0 | B | A | A | .... |

## KILNS AND KILN PRACTICE.

### NUMBER AND LENGTH OF KILNS IN OPERATION.

In 1907 the total number of rotary kilns in operation for all or part of the year was 876, an increase of 83 over the active kilns of 1906. Classified according to their length these kilns may be grouped as follows:

*Kilns in operation, classified according to length, in 1906 and 1907.*

| Length. | Number of kilns operated. | | Length. | Number of kilns operated. | |
|---|---|---|---|---|---|
| | 1906. | 1907. | | 1906. | 1907. |
| 60 feet and less | 398 | 362 | 120 feet | 17 | 41 |
| 70 to 78 feet | 40 | 43 | 125 feet and over | 57 | 117 |
| 80 feet | 69 | 85 | Of unspecified length | 14 | ........ |
| 85 to 95 feet | 66 | 68 | | | |
| 96 to 100 feet | 52 | 76 | Total | 793 | 876 |
| 104 to 110 feet | 80 | 84 | | | |

### AVERAGE ANNUAL OUTPUT PER KILN.

The relatively small quantity of Portland cement still made in vertical kilns being omitted, each active rotary kiln averaged 55,691 barrels in 1907. Compared with 1906, when the average annual output per kiln was 58,592 barrels, a small but noticeable decrease is shown. This is not due to any falling off in the average capacity of the kiln, for that has really shown an increase, but to the stoppage of many kilns during the latter part of the year.

The data as to number and output of kilns collected in earlier years may be summarized as follows for convenience in comparison:

*Number and average annual output of kilns, 1902–1907.*

| Year. | Number of active rotaries. | Average output per kiln (barrels). |
|---|---|---|
| 1902 | 456 | 36,909 |
| 1905 | 722 | 48,818 |
| 1906 | 793 | 58,592 |
| 1907 | 876 | 55,691 |

### KILNS UNDER CONSTRUCTION.

In the report for 1906 it was stated that, in addition to the 793 rotary kilns actually operated in 1906, 92 kilns were in course of construction and sufficiently far advanced to begin producing in 1907. This estimate was very close to the truth, for the number of kilns operated in 1907 was 876, a gain of 83 over the preceding year.

On January 1, 1908, there were under construction 87 new kilns, in plants sufficiently far advanced to become factors in the 1908 cement production, provided that market conditions should justify their operation. The number of these new kilns, classified according to size, is as follows:

*Kilns under construction, classified according to size, in 1907.*

| Number. | Length. |
|---|---|
| 20 kilns | 100 feet. |
| 22 kilns | 110 feet. |
| 9 kilns | 120 feet. |
| 36 kilns | 125 feet and over. |

### MAXIMUM ANNUAL CAPACITY OF CEMENT PLANTS IN THE UNITED STATES.

In view of the often repeated statement that the output of Portland cement in the United States is still far behind the possible demand for the product, it is of interest to consider the data as to kiln capacity already presented.

It has been stated that 876 kilns were in operation in 1907, and that 87 new kilns will be ready some time in 1908. This gives a total of 963 kilns which can be used if the cement trade become prosperous enough to justify it. As all the new kilns are 100 feet or more in length, and as many old kilns are being lengthened, it seems entirely safe to estimate that the average possible output per kiln per year is now considerably over 60,000 barrels. Assuming for convenience that this average is now about 62,000 barrels per kiln, it will be possible to make Portland cement during the latter part of 1908 at the rate of 5,000,000 barrels per month, or 60,000,000 barrels per year. In view of existing financial conditions, however, it would appear probable that the cement production of 1908 will not exceed that of 1907.

### FUELS IN USE.

The fuels used in Portland-cement kilns are powdered coal, oil, natural gas, and producer gas. The relative importance of these four fuels is well brought out by the following table, which is based upon the 1907 statistics.

Oil is used by all of the cement plants in Arizona, California, Texas, and Washington. Natural gas is used by all the operating Kansas plants, and by one plant elsewhere. A small output on producer gas at one plant is included in the natural-gas figures. Powdered coal is, however, the principal fuel used, 79 plants, with a total of 753 kilns, and producing 88.5 per cent of the total output, being equipped with powdered-coal burners.

*Fuels used in Portland-cement plants in 1907.*

| Fuel used. | Number of plants. | Number of kilns. | Output in 1907. | Percentage of total. |
|---|---|---|---|---|
| | | | *Barrels.* | |
| Powdered coal | 79 | 753 | 43,151,461 | 88.5 |
| Oil | 8 | 64 | 2,229,004 | 4.5 |
| Natural gas | 6 | 58 | 3,404,925 | 7.0 |
| Producer gas | 1 | 1 | | |
| Total | 94 | 876 | 48,785,390 | 100.0 |

### CONCENTRATION OF INTEREST IN THE CEMENT INDUSTRY.

The Portland-cement industry affords a peculiarly interesting example of an important and growing branch of manufacture whose future organization and control is still a matter of uncertainty. Ten or even five years ago the business of making Portland cement in the United States was confined to a number of comparatively small mills, each of which was practically independent. To-day there is a noticeable degree of concentration of interest in the industry, and three processes are at work to increase steadily this concentration. Owing to the peculiar character of the industry, the final result is still a matter of much doubt. In an earlier report of this series it was pointed out that it is impossible for any one organization to gain control of the supply of raw materials, so that in this industry the most effective basis for monopoly is not available. The ownership of comprehensive basic patents would, as noted later, afford a peculiarly serviceable type of control, inasmuch as patent monopolies are thoroughly legal in form.

Setting aside for the moment the possibility of monopoly, it can be said that the three factors which make for concentration of control are—

1. The normal growth of profitable plants.
2. Consolidation by stock control.
3. The growth of the patent-holding company.

### NORMAL GROWTH OF PROFITABLE PLANTS.

A well-located and well-managed plant always has opportunity for expansion which is denied to plants of less technical or financial soundness. Many plants in this country have had opportunities for growth, and some have seized these opportunities. Plants which are built or extended at the height of a boom period, and companies which pay out all the profits of prosperous years as dividends can hardly expect to share in this growth. For in by far the majority of instances, lack of growth in a cement plant has been due, not to defective raw materials or to lack of technical skill, but to unwise financial management either at the inception or during the active life of the company.

### CONSOLIDATION BY STOCK CONTROL.

Several strong groups of plants connected by stock control rather than by direct ownership are now in existence. Of these the most important is the Iola or Nicholson group, which controls seven plants, mostly in the Kansas district. A second important group is that controlled by Mr. W. J. Dingee and his associates, including plants in California, Washington, and Pennsylvania. The Cowhan series of plants located in Michigan, Iowa, Kansas, and Texas also requires notice in this connection, and a number of smaller examples of "community of interest" are known to exist.

### THE GROWTH OF THE PATENT-HOLDING COMPANY.

Numerous patents have been taken out in connection with various phases of the cement industry, but it is only within the last two years that the patent question has become of the first importance to the cement industry. This recent development is due to the organization and growth of a great patent-holding corporation.

Late in 1906 the North American Portland Cement Company was organized, with a capital stock of $10,000,000, this stock being held by the Atlas, Alpha, American, Lawrence, Lehigh, and Vulcanite cement companies. The North American Company took over from the Atlas Portland Cement Company the United States rights to the Hurry and the Seaman patents, which cover certain methods for the burning of pulverized coal in cement kilns. At a later date it acquired the Edison long-kiln and the Carpenter patents. The companies now licensed under this system include the six companies which control the North American and also the Whitehall, Northampton, Hexter, Edison, Nazareth, Pennsylvania, Penn-Allen, Catskill, Buckhorn, Phoenix, Bath, and Glens Falls Portland cement companies. In January, 1907, these licensed companies organized as the Association of Licensed Cement Manufacturers. The following material is quoted from a statement then issued:

> The purposes of the association include the general betterment of the mechanical and chemical processes used in making cement, the improvement of the quality of cement, dealing with matters of traffic and shipment and the establishment of an association laboratory for technical tests and experiments. It is understood that all existing and properly equipped cement plants will be granted licenses and admitted to membership. Infringers of the patents above referred to will be rigorously prosecuted.

Nearly 70 per cent of the output of the Portland-cement industry in this country is already represented by the association, this being double the annual production in Great Britain, the pioneer Portland-cement manufacturing country, equal to the combined output of England and France, and in excess of that of Germany

* * * * * *

The Association of Licensed Cement Manufacturers, with its facilities for tests and experiments, its investigation of mechanical and chemical problems, its establishment of standards of quality, and its assistance in obtaining proper shipping facilities and rates is expected to be of great benefit to its members.

### PRESENT STATUS OF THE INDUSTRY

The facts discussed in preceding paragraphs may be summarized as in the schedule below, which is an attempt to indicate the groupings at present existing in the domestic Portland-cement industry. This table is based on information supplied by those in control of most of the plants mentioned, and is believed to be substantially free from error.

*Present status of the Portland-cement industry in the United States.*

| Names of companies. | Location of plants. |
|---|---|
| 1. North American Portland Cement Company: | |
| Alpha Portland Cement Company | Alpha, N. J.; Martins Creek, Pa. |
| Martins Creek Portland Cement Company | Martins Creek, Pa. |
| American Cement Company | Egypt, Pa. |
| Central Cement Company | Egypt, Pa. |
| Reliance Cement Company | Egypt, Pa. |
| Seaboard Cement Company | Norfolk, Va.[a] |
| Atlas Portland Cement Company | Northampton, Pa.; Hannibal, Mo. |
| Lawrence Cement Company | Siegfried, Pa. |
| Lehigh Portland Cement Company | Ormrod, Pa.; Wellston, Ohio; Mitchell, Ind.; Des Moines, Iowa.[a] |
| Shenango Portland Cement Company | Newcastle, Pa. |
| Vulcanite Portland Cement Company | Vulcanite, N. J. |
| 2. Nicholson or Iola group: | |
| Iola Portland Cement Company | Iola, Kans. |
| United Kansas Portland Cement Company: | |
| Kansas Portland Cement Company | Iola, Kans. |
| Independence Portland Cement Company. | Independence, Kans. |
| Indian Portland Cement Company | Neodesha, Kans. |
| Dixie Portland Cement Company | Copenhagen, Tenn. |
| Iowa Portland Cement Company | Des Moines, Iowa.[a] |
| Texas Portland Cement Company | Dallas, Tex. |
| 3. United States Steel Corporation: | |
| Universal Portland Cement Company | Chicago, Ill.; Buffington, Ind.; Pittsburg, Pa.[a] |
| 4. Dingee group: | |
| Standard Portland Cement Company | Napa Junction, Cal. |
| Santa Cruz Portland Cement Company | Santa Cruz, Cal. |
| Northwestern Portland Cement Company | Kendall, Wash.[a] |
| Atlantic Portland Cement Company | Stockertown, Pa.[a] |
| Northampton Portland Cement Company | Stockertown, Pa. |
| Quaker Portland Cement Company | Sandts Eddy, Pa.[a] |
| 5. Cowhan group: | |
| Peninsular Portland Cement Company | Cement City, Mich. |
| Southwestern States Portland Cement Company. | Dallas, Tex.[a] |
| Western States Portland Cement Company | Independence, Kans. |
| Northwestern States Portland Cement Company. | Mason City, Iowa.[a] |
| 6. Sandusky Portland Cement Company | Bay Bridge, Ohio; Dixon, Ill.; Syracuse, Ind.; York, Pa. |

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[a] Plants thus designated are not yet in operation.

## NATURAL CEMENT.

### PRODUCTION.

The natural cement produced in the United States during 1907 amounted to 2,887,700 barrels, valued at $1,467,302. As compared with a production of 4,055,797 barrels, valued at $2,423,170, in 1906, this output indicates a decrease of about 29 per cent in quantity and of about 39 per cent in value in 1907.

### PRODUCTION BY STATES.

In the following table the natural cement production of 1907 is classified by States, the figures for 1906 being added for comparison:

*Production of natural cement in 1906 and 1907, by States.*

| State. | 1906. | | | State. | 1907. | | |
|---|---|---|---|---|---|---|---|
| | Number of works. | Quantity (barrels). | Value. | | Number of works. | Quantity (barrels). | Value. |
| Georgia | 3 | 180,500 | $98,075 | Illinois | 3 | 264,599 | $92,750 |
| Illinois | 3 | 365,843 | 118,221 | Indiana | 12 | 400,000 | 140,000 |
| Indiana | 12 | 600,000 | 240,000 | New York | 15 | 947,929 | 633,170 |
| Maryland | 4 | 63,350 | 32,675 | Pennsylvania | 4 | 645,871 | 263,969 |
| New York | 16 | 1,515,866 | 1,055,785 | Kansas | 2 | 129,077 | 71,052 |
| Pennsylvania | 4 | 744,403 | 560,534 | Texas | 1 | | |
| Kansas | 2 | 238,311 | 129,781 | Georgia | 2 | 338,195 | 176,379 |
| Texas | 1 | | | Kentucky | 2 | | |
| Kentucky | 2 | 170,194 | 95,539 | Maryland | 4 | | |
| Ohio | 1 | | | Ohio | 1 | | |
| Virginia | 1 | | | Virginia | 1 | | |
| Minnesota | 2 | 177,330 | 92,560 | Minnesota | 2 | 162,029 | 89,982 |
| North Dakota | 1 | | | North Dakota | 1 | | |
| Wisconsin | 2 | | | Wisconsin | 2 | | |
| Total | 54 | [a] 4,055,797 | [a] 2,423,170 | Total | 52 | 2,887,700 | 1,467,302 |

[a] A small quantity of hydraulic lime was produced in Georgia, Maryland, and New York, and is included in this table.

## COMPARISON OF PRODUCTION OF PORTLAND AND NATURAL CEMENT 1890–1907.

On examining the cement statistics for a series of years, it will be seen that the output of Portland cement has so far shown an increase each year, rising from 42,000 barrels in 1880 to 335,500 barrels in 1890, to 8,482,020 barrels in 1900, and to 48,785,390 barrels in 1907. The natural cement production, on the other hand, reached its maximum in 1899, with an output of 9,868,179 barrels. Since that year it has shown an almost continuous and quite rapid decrease annually, until now it has become a relatively unimportant factor in the cement situation. These facts are brought out clearly in the appended diagram (fig. 1).

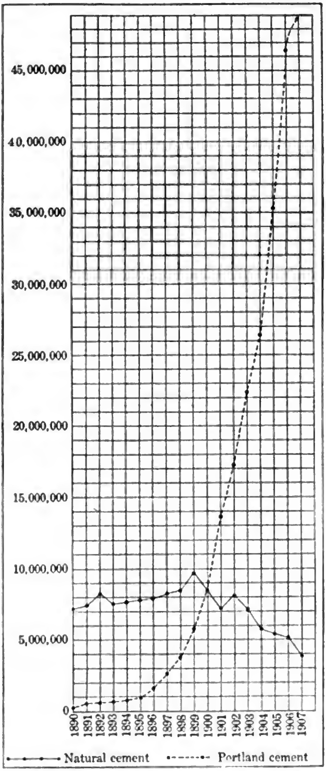

FIG. 6.—Comparison of production of Portland and natural cement, 1890-1907.

## PRODUCTION OF HYDRAULIC LIME IN THE UNITED STATES.

For the last two or three years several domestic natural-cement plants have been manufacturing and marketing a true hydraulic lime, similar in every technical respect to the well-known French hydraulic lime of Teil.

In 1907 the production of hydraulic lime amounted to 49,769 barrels, valued at $23,133, as compared with a production in 1906 of 40,800 barrels, valued at $19,300.

## PUZZOLAN CEMENT.

### PRODUCTION.

Puzzolan cement, made by mixing slag with slaked lime, was manufactured during 1907 to the amount of 557,252 barrels, valued at $443,998.

There are 10 plants equipped for the manufacture of slag cement in the United States. Of these, the States of Ohio and Alabama contain 2 plants each, while Illinois, Kentucky, Maryland, New Jersey, New York, and Pennsylvania have 1 plant each. During 1907 the plants in Maryland and New Jersey were idle.

Owing to this fact, it is impossible to distribute the total production in any instructive manner without disclosing individual statistics.

The following table contains the leading facts relative to this industry for the four years from 1904 to 1907, inclusive:

*Statistics of the puzzolan cement industry, 1904–1907.*

| | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| Number of plants: | | | | |
| Alabama | 2 | 2 | 2 | 2 |
| Illinois | 1 | 1 | 1 | 1 |
| Kentucky | | 1 | 1 | 1 |
| Maryland | 1 | 1 | 1 | 1 |
| New Jersey | 1 | 1 | 1 | 1 |
| New York | | | 1 | 1 |
| Ohio | 2 | 2 | 2 | 2 |
| Pennsylvania | 1 | 1 | 1 | 1 |
| Total | 8 | 9 | 10 | 10 |
| Production, in barrels | 303,045 | 382,447 | 481,224 | 557,252 |
| Value of production | $226,651 | $272,614 | $412,921 | $443,998 |

## IMPORTATION OF JAPANESE VOLCANIC ASH.

Reports that cargo loads of Japanese volcanic ash, for use in puzzolan cement, were being shipped to the Pacific coast of the United States in 1907 attracted considerable attention to that type of material. The data below are summarized from a consular report issued during the year.

The puzzolanic ash is widely distributed in Japan, the present workings being on the island of Kyushu, 7 miles inland from the port of Karatsu. The ash is dug, dried in the open air, roasted, and ground to 50 mesh or slightly finer. Four analyses of various samples of the ash are as follows:

*Analyses of Japanese volcanic ash.*

| | | | | |
|---|---|---|---|---|
| Silica | 41.95 | 42.10 | 44.15 | 42.63 |
| Alumina | 25.00 | 25.72 | 24.81 | 27.52 |
| Iron oxide | 18.56 | 18.28 | 17.40 | 16.83 |
| Lime | 1.33 | 1.15 | 1.57 | 0.03 |
| Magnesia | 0.92 | 0.85 | 0.94 | 0.96 |
| Soda and potash | 2.35 | 2.20 | 2.73 | 0.93 |
| Loss on ignition | 9.90 | 9.70 | 8.40 | 10.02 |

The following table shows the results of tensile tests of mixtures containing this material, made at the Sasebo naval depot, where large quantities have been used in Government work:

*Tensile tests of mixtures containing Japanese volcanic ash.*

| Quality of water used in experiments. | Proportions in weight of mixture. | | | | Tensile strength per square inch in English pounds. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Portland cement. | Lime. | Puzzolan cement. | Sand. | After 4 weeks. | After 3 months. | After 6 months. | After 12 months. | After 24 months. |
| Sea | 7 | ...... | 3 | 20 | 284 | 455 | 553 | 574 | 583 |
| | 6 | ...... | 4 | 20 | 284 | 405 | 469 | 432 | 515 |
| | 5 | ...... | 5 | 20 | 268 | 364 | 463 | 459 | 500 |
| Sulphate of magnesia | 7 | ...... | 3 | 20 | 278 | 431 | 500 | 511 | 518 |
| | 6 | ...... | 4 | 20 | 251 | 385 | 415 | 441 | 464 |
| | 5 | ...... | 5 | 20 | 238 | 340 | 414 | 427 | 472 |
| Fresh | 7 | ...... | 3 | 20 | 291 | 376 | 449 | 436 | 471 |
| | 6 | ...... | 4 | 20 | 243 | 345 | 426 | 414 | 439 |
| | 5 | ...... | 5 | 20 | 205 | 318 | 401 | 370 | 388 |
| Sea | 7 | ...... | 3 | 30 | 167 | 325 | 401 | 400 | 423 |
| | 6 | ...... | 4 | 30 | 158 | 264 | 300 | 300 | 349 |
| | 5 | ...... | 5 | 30 | 147 | 244 | 291 | 291 | 333 |
| Sulphate of magnesia | 7 | ...... | 3 | 30 | 167 | 277 | 296 | 260 | 311 |
| | 6 | ...... | 4 | 30 | 133 | 175 | 195 | 177 | 206 |
| | 5 | ...... | 5 | 30 | 116 | 170 | 162 | 176 | 265 |
| Fresh | 7 | ...... | 3 | 30 | 161 | 247 | 293 | 306 | 345 |
| | 6 | ...... | 4 | 30 | 152 | 256 | 285 | 291 | 331 |
| | 5 | ...... | 5 | 30 | 124 | 210 | 249 | 229 | 288 |
| Fresh | ........ | 2 | 8 | 20 | 160 | 312 | 271 | 306 | ......... |
| | ........ | 3 | 7 | 20 | 156 | 292 | 295 | 317 | ......... |
| | ........ | 2 | 8 | 30 | 122 | 215 | 214 | 214 | ......... |
| | ........ | 3 | 7 | 30 | 106 | 234 | 217 | 223 | ......... |

The following is a report of compression test of Karatsu volcanic ash said to have been made at the Kioto Imperial University:

*Compression test of Karatsu volcanic ash.*

| Description. | Proportion in volume. | | | Per square inch in pounds. | | | | |
|---|---|---|---|---|---|---|---|---|
| | Portland cement. | Volcanic ash. | Sand. | After 1 week. | After 4 weeks. | After 3 months. | After 6 months. | After 1 year. |
| Fresh water | 1 | .......... | 3 | 782.25 | 1,177.63 | 1,639.88 | 1,880.25 | 2,104.97 |
| Fresh water | .5 | 0.5 | 3 | 493.53 | 782.25 | 1,173.38 | 1,191.87 | 1,453.57 |

As a result of experience the Japanese company recommends the following mixtures, the proportions being in volumes:

For harbor, dock, and general sea work, ash 3, cement 2, sand 10; for water works, drains, river embankments, roads, and tunnels, ash 3, lime 1, cement 1, sand 10; for drains and plastering, ash 4, lime 2, cement 1.5, sand 10; for foundations and brick-work, ash 1, lime 1, sand 30 to 40; for concrete add gravel one and one-half to twice the quantity of sand used. Sand and gravel should be well washed and partially dried before mixing.

The following directions for mixing are given: Place the kneading stand at the desired spot. Have all the materials ready at hand. Have volcanic ash and lime or cement well mixed as desired, and adding sand to it, mix it again, pouring in a proper amount of water; knead it over and over, using sufficient pressure, and covering entirely the outside of sand with volcanic ash, etc., knead them until the different materials lose their own colors and come to one color.

The company prepares the ash, ready for use, packed in straw bags, weighing about 140 pounds each, the prices for which are at Nagasaki 70 sen (35 cents), at Kobe 80 sen (40 cents), and at Yokohama 1 yen (50 cents). In large quantities the prices, free on board ship, per ton of 2,000 pounds, are at Nagasaki and Shimonoseki (Moji) 10.5 yen ($5.23), at Kobe 12 yen ($5.98), at Yokohama 15 yen ($7.47). Freights from Nagasaki and Shimonoseki (Moji) to Seattle and San Francisco per ton of 2,000 pounds are about $4, and from Nagasaki to Manila about $2.50.

As very extensive deposits of similar volcanic ash are known to occur in the Rocky Mountain and Pacific coast States, it seems probable that the importation of Japanese ash will result in the development of the domestic deposits in the near future.

## IMPORTS, EXPORTS, AND CONSUMPTION.

The following tables show the imports for consumption, the exports, and the apparent consumption of hydraulic cement of all kinds in the United States for the years respectively mentioned:

*Imports for consumption of hydraulic cement into the United States, 1902–1907, in barrels.*

| | | | |
|---|---|---|---|
| 1902 | 1,963,023 | 1905 | 896,845 |
| 1903 | 2,251,969 | 1906 | 2,273,493 |
| 1904 | 968,410 | 1907 | 2,033,463 |

*Exports of hydraulic cement, 1902–1907 in barrels.*

| | | | |
|---|---|---|---|
| 1902 | 340,821 | 1905 | 897,686 |
| 1903 | 285,463 | 1906 | 583,299 |
| 1904 | 774,940 | 1907 | 900,550 |

*Total consumption of hydraulic cement in 1907, in barrels.*

| | |
|---|---|
| Total production in the United States | 52,230,342 |
| Imports withdrawn for consumption | 2,033,463 |
| Total | 54,263,805 |
| Exports | 900,550 |
| Total apparent consumption | 53,363,255 |

# CLAY-WORKING INDUSTRIES.

By JEFFERSON MIDDLETON.

## INTRODUCTION.

With the exception of the section on clay production, this report deals with the products of the clay-working industries, and hence the tables are made up to show the products of clay manufactured and not the production of clay.

The year under review, 1907, was one of unusual interest from the standpoint of production, not only in the clay-working industries, but in all industrial lines. The financial disturbance of October came too late to affect the clay industries very seriously, as is shown by the figures given in this report. This was especially true of the brick and tile industries, since building and engineering operations, at least where climatic conditions affect them, were either completed or too far advanced to be much influenced by want of confidence or lack of capital; consequently the loss in these industries was very slight, being only 0.61 of 1 per cent in value of output. On the other hand, the pottery industry, whose sales are probably heaviest during the fall and winter, was appreciably affected by the financial stress, and the value of these products fell considerably—4.13 per cent, as compared with 1906.

Notwithstanding these losses, the value of the clay products in 1907 is considerably greater than it was in 1905, which was a year of unusual prosperity, the difference in favor of 1907 in comparison with 1905 being $9,245,181, or 6.18 per cent. The year 1907 must, therefore, be considered one of great activity in the clay industries, and only by comparison with 1906, the most prosperous in the history of the country, does it suffer, and then but slightly, as the total decrease in volume of business represented by the value of the product was 1.30 per cent.

The most noteworthy incidents in the history of the trade during 1907 were the large increase in the value of the paving-brick product, the decrease in the brick industry along the Hudson River, and the large gain in the value of products in California, West Virginia, Illinois, and Texas.

The increase in the paving-brick industry is probably due to the inherent qualities of brick as a paving material and the educational campaign conducted by the National Association of Paving Brick Manufacturers for several years. The decrease along the Hudson River and the increases in California, Illinois, and Texas are due to local causes. The increase in West Virginia is due to increased output of pottery and paving brick.

The labor situation in the building trades and the clay-working industries was good in 1907, no general strike being in force, though there is always more or less disturbance of local character.

The year 1908, owing to financial and political causes, will probably show a considerable decrease from the product reported for 1907.

The total value of all clay products marketed in the United States in 1907 was $158,942,369, compared with $161,032,722 in 1906, a loss of $2,090,353, or 1.30 per cent. In 1906 the gain over 1905 was $11,335,534, or 7.57 per cent. The increase of 1905 over 1904 was $18,673,940, or 14.25 per cent.

## ACKNOWLEDGMENTS.

Again, the writer, on behalf of the office, desires to thank the clay workers of the country for their cooperation, without which this report would be impossible.

Thanks are also extended to the officials who have supplied information concerning the building operations of the various cities of the country, and to the clay-working press for its support and appreciation.

As in previous years, the State geological surveys of Illinois, Iowa, Maryland, and North Carolina have cooperated in the collection of the statistics of their States, the completeness of the returns for these States being due largely to their efforts. For 1907 the State surveys of Alabama and Missouri also gave assistance in the collection of these statistics for those States.

## BUILDING OPERATIONS.

The following tables show the number of permits issued or of buildings erected thereunder in the leading cities of the country from 1900 to 1907 by years, the number in 1906 and 1907 by cities, the increase or decrease in the cost of the buildings erected in each city and the total decrease in 1907, together with the percentage of increase or decrease in each case, and the percentage of the total decrease; also in certain cities the number and cost of the so-called fireproof or fire-resisting buildings and those of wood. In some instances more than one building is erected under the same permit, though in most cities one permit is issued for each building.

*Building operations in the leading cities in the United States, 1900–1907.*

| Year. | Number of cities reporting. | Number of permits. | Cost of buildings. | Gain (+) or loss (−) over preceding year. | Percentage of gain or loss over preceding year. |
|---|---|---|---|---|---|
| 1900 | 42 | 68,417 | $241,516,585 | (a) | (a) |
| 1901 | 46 | 79,029 | 365,420,904 | +$123,904,319 | + 51.30 |
| 1902 | 45 | 96,423 | 368,469,037 | + 3,048,133 | + .83 |
| 1903 | 46 | 131,000 | 401,594,169 | + 33,125,132 | + 8.99 |
| 1904 [b] | 49 | 140,652 | 469,318,575 | + 67,724,406 | + 16.86 |
| 1905 | 49 | 185,806 | 644,620,873 | + 175,302,298 | + 37.35 |
| 1906 | 49 | 181,174 | 678,710,969 | + 34,090,096 | + 5.29 |
| 1907 | 49 | 184,055 | 661,076,286 | − 17,634,683 | − 2.06 |

[a] Statistics not collected prior to 1900.
[b] One city estimated.

From the foregoing table it will be seen that the number of cities reporting varied somewhat, especially in the first few years; for the last four years they have been the same. Estimating the building operation in Lowell, the only city that did not report in 1904, the totals for that year were permits 140,652 and cost of buildings erected $469,318,575. Comparing the last four years, when the cities reporting are the same, the total cost of buildings erected varied from $469,318,575 in 1904 to $678,710,969, its highest, in 1906, an increase of $209,392,394, or 44.62 per cent. In 1907 the cost of the buildings erected in these cities decreased $17,634,683, or 2.60 per cent, as compared with 1906, when there was a gain of $34,090,096 over 1905. The largest gain was in 1905. Notwithstanding the loss in 1907 the total cost of the buildings erected in that year was $16,455,413, or 2.55 per cent, greater than in 1905, and $191,757,711, or 40.86 per cent greater than in 1904.

*Building operations in the leading cities of the United States in 1906 and 1907.*

| City. | 1906. | | 1907. | | Gain (+) or loss (−) in 1907. | Percentage of gain or loss in 1907. |
|---|---|---|---|---|---|---|
| | Number of permits or buildings. | Cost of buildings. | Number of permits or buildings. | Cost of buildings. | | |
| Allegheny, Pa | 713 | $2,080,634 | 609 | $2,224,541 | + $143,907 | + 6.92 |
| Atlanta, Ga | 3,741 | 5,156,149 | 4,169 | 4,554,771 | − 601,378 | − 11.66 |
| Baltimore, Md | 2,826 | 12,619,970 | 3,129 | 8,250,677 | − 4,369,293 | − 34.62 |
| Boston, Mass | 3,328 | 23,064,741 | 3,546 | 19,223,226 | − 3,841,515 | − 16.66 |
| Brooklyn, N. Y | 18,083 | 71,442,148 | 17,397 | 71,292,844 | − 149,304 | − .21 |
| Buffalo, N. Y | 2,867 | 8,686,030 | 3,049 | 8,742,082 | + 56,052 | + .65 |
| Cambridge, Mass | 457 | 1,458,105 | 451 | 2,729,345 | + 1,271,240 | + 87.18 |
| Chicago, Ill | 10,641 | 64,709,325 | 9,353 | 59,093,080 | − 5,616,245 | − 8.68 |
| Cincinnati, Ohio | 2,130 | 7,065,746 | 2,215 | 7,680,160 | + 614,414 | + 8.70 |
| Cleveland, Ohio | 7,553 | 12,972,974 | 8,174 | 15,888,407 | + 2,915,433 | + 22.47 |
| Columbus, Ohio | 2,025 | 4,006,175 | 2,173 | 4,181,260 | + 175,085 | + 4.37 |
| Dayton, Ohio | 1,223 | 2,898,380 | 1,394 | 3,837,180 | + 938,800 | + 32.39 |
| Denver, Colo | 2,461 | 7,000,996 | 2,509 | 6,349,604 | − 651,392 | − 9.30 |
| Detroit, Mich | 4,706 | 13,275,250 | 4,941 | 14,226,300 | + 951,050 | + 7.16 |
| Fall River, Mass | 275 | 939,325 | 312 | 1,414,916 | + 475,591 | + 50.63 |
| Grand Rapids, Mich | 1,250 | 2,181,307 | 1,174 | 2,053,755 | − 127,552 | − 5.85 |
| Hartford, Conn | 652 | 3,732,915 | 733 | 4,054,335 | + 321,420 | + 8.61 |
| Indianapolis, Ind | 3,825 | 5,530,998 | 3,903 | 5,893,726 | + 362,728 | + 6.56 |
| Jersey City, N. J | 1,503 | 4,334,244 | 1,687 | 6,008,014 | + 1,673,770 | + 38.62 |
| Kansas City, Kans | 541 | 3,622,670 | 944 | 1,472,279 | − 2,150,391 | − 59.36 |
| Kansas City, Mo | 3,993 | 10,765,480 | 3,943 | 9,611,922 | − 1,153,558 | − 10.72 |
| Los Angeles, Cal | 9,358 | 18,502,446 | 7,599 | 13,304,696 | − 5,197,750 | − 28.09 |
| Louisville, Ky | 2,916 | 5,116,917 | 2,634 | 3,078,404 | − 2,038,513 | − 39.84 |
| Lowell, Mass | 353 | 901,745 | 441 | 1,225,317 | + 323,572 | + 35.88 |
| Memphis, Tenn | 2,549 | 4,346,767 | 2,502 | 4,957,999 | + 611,232 | + 14.06 |
| Milwaukee, Wis | 3,782 | 9,713,284 | 3,625 | 10,771,244 | + 1,057,960 | + 10.89 |
| Minneapolis, Minn | 4,724 | 9,466,150 | 4,960 | 10,006,485 | + 540,335 | + 5.71 |
| Nashville, Tenn | 5,124 | 2,840,212 | 5,202 | 2,040,458 | − 799,754 | − 28.16 |
| Newark, N. J | 1,946 | 10,411,328 | 2,732 | 9,543,520 | − 867,808 | − 8.34 |
| New Haven, Conn | 687 | 3,018,890 | 781 | 2,824,942 | − 193,948 | − 6.42 |
| New Orleans, La | ........ | 5,098,773 | 1,880 | 5,815,247 | + 716,474 | + 14.05 |
| New York, N. Y | 8,573 | 154,964,655 | 7,470 | 113,372,673 | −41,591,982 | − 26.84 |
| Omaha, Nebr | 1,093 | 4,273,050 | 1,500 | 4,536,643 | + 263,593 | + 6.17 |
| Philadelphia, Pa | 17,872 | 40,711,510 | 15,359 | 36,352,075 | − 4,359,435 | − 10.71 |
| Pittsburg, Pa | 3,738 | 15,370,047 | 3,631 | 12,740,762 | − 2,629,285 | − 17.11 |
| Providence, R. I | 1,350 | 3,983,300 | 1,201 | 3,224,400 | − 758,900 | − 19.05 |
| Reading, Pa | 1,347 | 1,645,135 | 1,193 | 1,532,050 | − 113,085 | − 6.87 |
| Richmond, Va | 740 | 2,504,895 | 701 | 1,914,184 | − 590,711 | − 23.58 |
| Rochester, N. Y | 1,373 | 6,175,478 | 1,420 | 6,752,615 | + 577,137 | + 9.35 |
| St. Joseph, Mo | 808 | 1,052,746 | 824 | 1,667,563 | + 614,817 | + 58.40 |
| St. Louis, Mo | 8,988 | 29,938,693 | 8,554 | 21,893,167 | − 8,045,526 | − 26.87 |
| St. Paul, Minn | 2,813 | 9,537,449 | 1,802 | 6,321,937 | − 3,215,512 | − 33.71 |
| San Francisco, Cal | 5,686 | 34,927,396 | 12,126 | 91,502,240 | +56,574,844 | +161.98 |
| Scranton, Pa | 1,097 | 2,174,075 | 937 | 2,435,024 | + 260,949 | + 12.00 |
| Seattle, Wash | 7,194 | 11,875,397 | 10,478 | 13,572,770 | + 1,697,373 | + 14.29 |
| Syracuse, N. Y | 1,057 | 3,313,261 | 1,299 | 4,222,282 | + 909,021 | + 27.44 |
| Toledo, Ohio | 1,759 | 4,696,058 | 1,176 | 3,400,665 | − 1,295,393 | − 27.58 |
| Washington, D. C | 8,453 | 11,668,347 | 5,015 | 10,215,604 | − 1,452,743 | − 12.45 |
| Worcester, Mass | 912 | 2,939,403 | 1,028 | 3,068,896 | + 129,493 | + 4.41 |
| Total | 181,174 | 678,710,969 | 184,055 | 661,076,286 | −17,634,683 | − 2.60 |

This table shows a comparison of the building industries in the cities in 1907 and 1906. Of these 49 cities 24 showed a decrease and 25 an increase. The total of the increases was $74,176,290; the decreases totaled $91,810,973, a net decrease of $17,634,683. While the total cost of buildings decreased, the total number of permits increased from 181,174 to 184,055. The city showing the greatest decrease in 1907 in cost of buildings was New York, which fell off in value $41,591,982, or 26.84 per cent. In 1905 the value of buildings erected in New York was $178,032,527. St. Louis, after enjoying great prosperity in the building industry since the time just preceding the Louisiana Purchase Exposition, showed the second largest decrease, $8,045,526, or 26.87 per cent. The city showing the next largest decrease was Chicago, which reported a falling off of $5,616,245, or 8.68 per cent, and the progressive city of Los Angeles, which has shown remarkable increases of late years, also showed a decrease. The cause of the falling off in Los Angeles does not appear to have been so much due to the financial depression as to the scarcity and high cost of material. Baltimore, after showing large gains in 1904 and 1905, caused by the fire of 1904, was found in both 1906 and 1907 in the list of cities showing a decrease in the cost of its building operations, though they were more than twice as great in 1907 as in 1903, when the cost was $3,327,225. Philadelphia, Boston, and Brooklyn also showed decreases in 1907. Brooklyn, however, nearly held its own, the decrease being only $149,304, or 0.21 of 1 per cent, the best showing of any of the very large cities where general conditions prevailed. In San Francisco, owing to local conditions, the increase was $56,574,844, or 161.98 per cent. In the other cities the increases, where shown, were with few exceptions small. In Cambridge, which showed the largest proportional gain, except San Francisco, several large mercantile buildings were erected, which swelled the total, and in Cleveland the building industry did not seem to have been affected by the general financial trouble, and reported an increase of $2,915,433, or 22.47 per cent, over 1906. Milwaukee showed an increase of over $1,000,000, due to the increased number of fireproof or fire-resisting buildings erected.

*Character of buildings erected in the leading cities of the United States in 1907.*

| City. | Brick and stone. | | Wood. | |
|---|---|---|---|---|
| | Number of permits. | Value. | Number of permits. | Value. |
| Atlanta, Ga | 108 | $1,574,948 | 1,698 | $2,322,681 |
| Boston, Mass | 355 | 10,607,367 | 865 | 4,464,052 |
| Brooklyn, N. Y | 6,132 | 57,090,213 | 2,346 | 7,059,894 |
| Buffalo, N. Y | 166 | 2.918,689 | 1,734 | 4,097,418 |
| Cambridge, Mass | 25 | 1,150,000 | 80 | 693,210 |
| Chicago, Ill | 7,043 | 43,391,080 | 2,310 | 15,702,000 |
| Cincinnati, Ohio | 534 | 5.528,202 | 705 | 1,364,513 |
| Cleveland, Ohio | 5,024 | 9,558,262 | 3,150 | 4,698,530 |
| Columbus, Ohio | 675 | 2,787,592 | 1,498 | 1,393,668 |
| Dayton, Ohio | 149 | 2,044,600 | 1,086 | 1,693,740 |
| Denver, Colo | 1,639 | 5,693,115 | 415 | 208,175 |
| Detroit, Mich | 400 | 5,000,000 | 3,842 | 7,226,300 |
| Fall River, Mass | 39 | 746,300 | 162 | 400,000 |
| Grand Rapids, Mich | 61 | 602,728 | 662 | 994,504 |
| Hartford, Conn | 134 | 2,845,026 | 344 | 871,630 |
| Indianapolis, Ind | 366 | 1,956,159 | 2,044 | 3,350,452 |
| Kansas City, Kans | 47 | 413,000 | 856 | 1,040,279 |
| Kansas City, Mo | 380 | 4,934,522 | 1,537 | 3,671,125 |
| Los Angeles, Cal | 219 | 4,793.658 | 4,810 | 7,125,601 |
| Louisville, Ky | 278 | 1,512,913 | 1,490 | 1,322,312 |
| Lowell, Mass | 13 | 531,100 | 188 | 474,648 |

*Character of buildings erected in the leading cities of the United States in 1907*—Continued.

| City. | Brick and stone. | | Wood. | |
|---|---|---|---|---|
| | Number of permits. | Value. | Number of permits. | Value. |
| Memphis, Tenn | 138 | $2,703,470 | 1,118 | $1,841,754 |
| Milwaukee, Wis | 199 | 5,071,128 | 1,517 | 4,292,795 |
| Minneapolis, Minn | 267 | 4,036,530 | 2,373 | 4,378,795 |
| Nashville, Tenn | 290 | 1,042,066 | 1,464 | 533,078 |
| Newark, N. J | 631 | 3,181,174 | 2,101 | 6,362,346 |
| New Haven, Conn | 99 | 1,272,068 | 385 | 1,244,076 |
| New York, N. Y | 1,821 | 90,490,394 | 1,094 | 5,234,205 |
| Omaha, Nebr | 165 | 2,305,603 | 966 | 1,935,325 |
| Philadelphia, Pa | 9,058 | 29,178,535 | 46 | 82,780 |
| Pittsburg, Pa | 597 | 7,552,709 | 1,330 | 3,258,209 |
| Providence, R. I | 54 | 1,068,900 | 664 | 1,705,950 |
| Reading, Pa | 790 | 1,499,550 | ........ | ........ |
| Richmond, Va | 305 | 1,488,850 | 277 | 332,054 |
| Rochester, N. Y | 122 | 2,538,790 | 1,298 | 3,373,675 |
| St. Joseph, Mo | 64 | 927,175 | 421 | 581,632 |
| St. Louis, Mo | 2,313 | 18,923,897 | 3,794 | 1,039,104 |
| St. Paul, Minn | 120 | 2,540,975 | 1,167 | 2,474,355 |
| San Francisco, Cal | 1.190 | 51,928,892 | 7,453 | 32,579,343 |
| Scranton, Pa | 45 | 557,991 | 458 | 1,686,250 |
| Seattle, Wash | 96 | 5,769,525 | 5.450 | 6,318,607 |
| Syracuse, N. Y | 55 | 1,720,196 | 632 | 1,746,448 |
| Washington, D. C | 891 | 6,995,916 | 835 | 1,488,380 |
| Worcester, Mass | 48 | 961,050 | 473 | 1,341.733 |
| Total | 43.145 | 409,434,858 | 67,138 | 154,005,626 |

This table shows the character of the buildings erected—that is, those of brick or stone or other fire-resisting material and those of wood. Of the 49 cities reporting, 44 reported by classes for 1907 as compared with 35 for 1906. Of the permits issued or buildings erected, 60.88 per cent were for wooden buildings and 39.12 per cent for fire-resisting buildings, thus showing that even in the larger cities of the country the buildings of wood are greatly in excess of the fire-resisting and more permanent buildings, although, as one would expect, the value of the latter class is much greater than that of the former, $154,005,626, or 27.33 per cent, being the total cost of the wooden and $409,434,858, or 72.67 per cent, the total cost of the brick or stone buildings. A further evidence of the value of the different classes is shown by the individual cost; the average cost of brick or stone buildings was $9,490 compared with $2,294 for the wooden buildings. Philadelphia shows the largest number of brick or stone buildings erected and, with the exception of Reading, the smallest number of wooden buildings. The average cost of the former was $3,221 and of the latter $1,800. In New York the average cost of brick or stone buildings was $49,693. There were no wooden buildings erected in the borough of Manhattan, those reported being in the Bronx; nor were any erected in Reading. Of the larger cities Brooklyn, next to New York, reports the greatest cost of brick or stone buildings, although the average was comparatively small, being $9,310. In Chicago, too, the average cost of brick or stone buildings, $6,161, was low. The substantial character of the buildings erected in San Francisco is shown by the average cost, the 1,190 brick or stone buildings averaging $43,638. In Cambridge, the average cost was $46,000 for fire-resisting buildings. In Lowell, the average was $40,854. The highest average of all cities, however, was $60,099, in Seattle. San Francisco reports the largest number of wooden buildings, 7,453, costing $32,579,343, an average of $4,371 each. The only other city reporting wooden buildings to the cost of over

$10,000,000 was Chicago, which erected 2,310 buildings of this character at a cost of $15,702,000, or an average of $6,797 per building—a greater average than for buildings of stone or brick, and a very high average for this class of structure. In the Bronx, New York City, there were erected 1,094 wooden buildings at a cost of $5,234,205, or an average of $4,784 each. The cost of the wooden buildings erected exceeded the cost of the fire-resisting buildings in 15 cities, namely: Atlanta, Buffalo, Detroit, Grand Rapids, Indianapolis, Kansas City, Kans., Los Angeles, Minneapolis, Newark, Providence, Rochester, Scranton, Seattle, Syracuse, and Worcester.

## PRODUCTION.

In the following table will be found a statement of the value of the clay products of the United States in 1906 and 1907:

*Value of the products of clay in the United States in 1906 and 1907, by States and Territories.*

| State or Territory. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Brick and tile. | Pottery. | Total. | Brick and tile. | Pottery. | Total. |
| Alabama | $1,650,903 | $37,996 | $1,688,899 | $1,726,664 | $27,745 | $1,754,409 |
| Arizona | 93,694 | | 93,694 | 101,462 | | 101,462 |
| Arkansas | 512,694 | 19,500 | 532,194 | 519,336 | 16,950 | 536,286 |
| California | 4,265,633 | 98,597 | 4,364,230 | 5,642,699 | 97,838 | 5,740,537 |
| Colorado | 1,784,005 | 47,083 | 1,831,088 | 1,997,331 | 44,144 | 2,041,475 |
| Connecticut and Rhode Island | 1,613,761 | [a] 133,444 | 1,747,205 | 1,361,476 | [a] 123,116 | 1,484,592 |
| Delaware | 237,768 | | 237,768 | 190,440 | | 190,440 |
| District of Columbia | 335,139 | (b) | 335,139 | 322,084 | (b) | 322,084 |
| Florida | 289,644 | (b) | 289,644 | 354,575 | (b) | 354,575 |
| Georgia | 2,380,367 | 20,257 | 2,400,624 | 2,456,352 | 33,885 | 2,490,237 |
| Idaho and Nevada | 282,889 | | 282,889 | 327,078 | | 327,078 |
| Illinois | 11,651,278 | 982,903 | 12,634,181 | 12,216,323 | 1,004,166 | 13,220,489 |
| Indiana | 6,224,541 | 933,693 | 7,158,234 | 5,988,970 | 869,154 | 6,858,124 |
| Indian Territory | 299,790 | | 299,790 | | | |
| Iowa | 3,411,027 | 58,000 | 3,469,027 | 3,709,903 | 18,882 | 3,728,785 |
| Kansas | 2,432,371 | (b) | 2,432,371 | 2,370,058 | (b) | 2,370,058 |
| Kentucky | 2,425,214 | 167,209 | 2,592,423 | 2,444,743 | 166,621 | 2,611,364 |
| Louisiana | 894,277 | 6,420 | 900,697 | 922,877 | 5,693 | 928,570 |
| Maine | 680,370 | (b) | 680,370 | 658,913 | (b) | 658,913 |
| Maryland | 1,763,040 | 373,499 | 2,136,539 | 1,519,465 | 366,897 | 1,886,362 |
| Massachusetts | 1,895,199 | 277,534 | 2,172,733 | 1,826,076 | 302,744 | 2,128,820 |
| Michigan | 1,793,367 | 51,110 | 1,844,477 | 1,786,190 | 61,574 | 1,847,764 |
| Minnesota | 1,603,279 | (b) | 1,603,279 | 1,689,933 | (b) | 1,689,933 |
| Mississippi | 831,769 | 19,311 | 851,080 | 825,408 | 21,121 | 846,529 |
| Missouri | 6,626,775 | 69,500 | 6,696,275 | 6,820,684 | 78,187 | 6,898,871 |
| Montana | 297,299 | (b) | 297,299 | 272,872 | (b) | 272,872 |
| Nebraska | 990,708 | | 990,708 | 953,432 | | 953,432 |
| New Hampshire | 726,051 | (b) | 726,051 | 510,599 | (b) | 510,599 |
| New Jersey | 10,079,611 | 7,282,658 | 17,362,269 | 9,019,834 | 6,985,626 | 16,005,460 |
| New Mexico | 152,599 | | 152,599 | 180,284 | | 180,284 |
| New York | 12,008,260 | 1,868,347 | 13,876,607 | 9,838,376 | 1,934,498 | 11,772,874 |
| North Carolina | 1,170,568 | 11,770 | 1,182,338 | 1,305,600 | 10,222 | 1,315,822 |
| North Dakota | 269,873 | | 269,873 | 287,919 | | 287,919 |
| Ohio | 17,023,806 | 13,990,359 | 31,014,165 | 16,807,631 | 13,533,199 | 30,340,830 |
| Oklahoma | 241,111 | | 241,111 | 664,512 | | 664,512 |
| Oregon | 506,192 | (b) | 506,192 | 545,839 | (b) | 545,839 |
| Pennsylvania | 19,363,794 | 2,410,817 | 21,774,611 | 18,981,743 | 1,309,878 | 20,291,621 |
| South Carolina | 805,212 | 25,269 | 830,481 | 829,029 | 14,350 | 843,379 |
| South Dakota | 58,175 | | 58,175 | 40,107 | | 40,107 |
| Tennessee | 1,405,458 | 214,768 | 1,620,226 | 1,446,647 | 167,215 | 1,613,862 |
| Texas | 1,860,963 | 108,635 | 1,969,598 | 2,401,388 | 156,173 | 2,557,561 |
| Utah | 632,344 | 2,100 | 634,444 | 633,387 | (b) | 633,387 |
| Vermont | 112,368 | | 112,368 | 109,500 | | 109,500 |
| Virginia | 1,966,078 | (b) | 1,966,078 | 1,611,335 | (b) | 1,611,335 |
| Washington | 1,458,324 | 41,560 | 1,499,884 | 1,891,239 | 30,695 | 1,921,934 |
| West Virginia | 1,194,757 | 1,588,555 | 2,783,312 | 1,481,255 | 2,159,132 | 3,640,387 |
| Wisconsin | 1,215,172 | 12,170 | 1,227,342 | 1,118,987 | 8,832 | 1,127,819 |
| Wyoming | 74,321 | | 74,321 | 88,340 | | 88,340 |
| Other States | | 587,820 | 587,820 | | 594,937 | 594,937 |
| Total | 129,591,838 | 31,440,884 | 161,032,722 | 128,798,895 | 30,143,474 | 158,942,369 |
| Per cent of total | 80.48 | 19.52 | 100.00 | 81.03 | 18.97 | 100.00 |

[a] Produced by Connecticut alone.

[b] Included in other States.

This table shows that the marketed clay products of the United States in 1907 were valued at $158,942,369, as against $161,032,722 in 1906, a decrease of $2,090,353, or 1.30 per cent.

Of the output for 1907, the brick and tile of this classification, the materials which enter most largely into structural and engineering arts, were valued at $128,798,895, or 81.03 per cent, and the pottery or finer grade of goods was valued at $30,143,474, or 18.97 per cent. These relative percentages about 80 and 20 have been maintained for a number of years. In 1905 the value of the brick and tile products was $121,778,294, or 81.35 per cent, and the pottery products $27,918,894, or 18.65 per cent.

Every State and Territory contributes to this total, though in Rhode Island and Nevada there were not a sufficient number of producers to permit the publication of State totals without disclosing individual statements, so that these States are combined with contiguous ones.

*Value of the clay products of the United States, by States, in 1906 and 1907, showing increase or decrease, with percentage of increase or decrease.*

| State. | 1906. | 1907. | Increase (+) and decrease (−) in 1907. | Percentage of increase (+) and decrease (−) in 1907. |
|---|---|---|---|---|
| Alabama | $1,688,899 | $1,754,409 | + $65,510 | + 3.88 |
| Arizona | 93,694 | 101,462 | + 7,768 | + 8.29 |
| Arkansas | 532,194 | 536,286 | + 4,092 | + .77 |
| California | 4,364,230 | 5,740,537 | +1,376,307 | +31.54 |
| Colorado | 1,831,088 | 2,041,475 | + 210,387 | +11.49 |
| Connecticut and Rhode Island | 1,747,205 | 1,484,592 | − 262,613 | −15.03 |
| Delaware | 237,768 | 190,440 | − 47,328 | −19.91 |
| District of Columbia | 335,139 | 322,084 | − 13,055 | − 3.90 |
| Florida | 289,644 | 354,575 | + 64,931 | +22.42 |
| Georgia | 2,400,624 | 2,490,237 | + 89,613 | + 3.73 |
| Idaho and Nevada | 282,889 | 327,078 | + 44,189 | +15.62 |
| Illinois | 12,634,181 | 13,220,489 | + 586,308 | + 4.64 |
| Indiana | 7,158,234 | 6,858,124 | − 300,110 | − 4.19 |
| Iowa | 3,469,027 | 3,728,785 | + 259,758 | + 7.49 |
| Kansas | 2,432,371 | 2,370,058 | − 62,313 | − 2.56 |
| Kentucky | 2,592,423 | 2,611,364 | + 18,941 | + .73 |
| Louisiana | 900,697 | 928,570 | + 27,873 | + 3.09 |
| Maine | 680,370 | 658,913 | − 21,457 | − 3.15 |
| Maryland | 2,136,539 | 1,886,362 | − 250,177 | −11.71 |
| Massachusetts | 2,172,733 | 2,128,820 | − 43,913 | − 2.02 |
| Michigan | 1,844,477 | 1,847,764 | + 3,287 | + .18 |
| Minnesota | 1,603,279 | 1,689,933 | + 86,654 | + 5.40 |
| Mississippi | 851,080 | 846,529 | − 4,551 | − .53 |
| Missouri | 6,696,275 | 6,898,871 | + 202,596 | + 3.03 |
| Montana | 297,299 | 272,872 | − 24,427 | − 8.22 |
| Nebraska | 990,708 | 953,432 | − 37,276 | − 3.76 |
| New Hampshire | 726,051 | 510,599 | − 215,452 | −29.67 |
| New Jersey | 17,362,269 | 16,005,460 | −1,356,809 | − 7.81 |
| New Mexico | 152,599 | 180,284 | + 27,685 | +18.14 |
| New York | 13,876,607 | 11,772,874 | −2,103,733 | −15.16 |
| North Carolina | 1,182,338 | 1,315,822 | + 133,484 | +11.29 |
| North Dakota | 269,873 | 287,919 | + 18,046 | + 6.69 |
| Ohio | 31,014,165 | 30,340,830 | − 673,335 | − 2.1 |
| Oklahoma | [a] 540,901 | 664,512 | + 123,611 | +22.85 |
| Oregon | 506,192 | 545,839 | + 39,647 | + 7.83 |
| Pennsylvania | 21,774,611 | 20,291,621 | −1,482,990 | − 6.81 |
| South Carolina | 830,481 | 843,379 | + 12,898 | + 1.55 |
| South Dakota | 58,175 | 40,107 | − 18,068 | −31.06 |
| Tennessee | 1,620,226 | 1,613,862 | − 6,364 | − .39 |
| Texas | 1,969,598 | 2,557,561 | + 587,963 | +29.85 |
| Utah | 634,444 | 633,387 | − 1,057 | − .17 |
| Vermont | 112,368 | 109,500 | − 2,868 | − 2.55 |
| Virginia | 1,966,078 | 1,611,335 | − 354,743 | −18.04 |
| Washington | 1,499,884 | 1,921,934 | + 422,050 | +28.14 |
| West Virginia | 2,783,312 | 3,640,387 | + 857,075 | +30.79 |
| Wisconsin | 1,227,342 | 1,127,819 | − 99,523 | − 8.11 |
| Wyoming | 74,321 | 88,340 | + 14,019 | +18.86 |
| Other States | [b] 587,820 | [b] 594,937 | + 7,117 | + 1.21 |
| Total | 161,032,722 | 158,942,369 | −2,090,353 | − 1.30 |

[a] Includes Indian Territory.

[b] Includes pottery products which could not be separately classified without disclosing individual figures.

Of the States and Territories represented by the 47 totals, 25 showed gains and 22 losses in 1907. Thirty-seven showed gains and 11 losses in 1906, there being one more total than in 1907 by reason of Indian Territory, which is now merged with Oklahoma. In 1907 the increases ranged from $3,287, or 0.18 of 1 per cent, in Michigan to $1,376,307, or 31.54 per cent, in California; and the decreases ranged from $1,057, or 0.17 of 1 per cent, in Utah to $2,103,733, or 15.16 per cent, in New York. The gains and losses do not appear to be confined to any definite portions of the country. The largest gain and the largest loss may easily be accounted for, the former by the local conditions produced by the earthquake and fire, and the latter by the decrease in the brickmaking industry along Hudson River. Of the 11 States which showed decreases in 1906, 8 showed decreases in 1907—Maryland, Montana, Nebraska, New York, South Dakota, Vermont, Virginia, and Wisconsin. In 1906 none of the leading clay-working States, except New York, showed a decrease; in 1907 all of the first five, except Illinois, show large decreases. Next to California, the State showing the largest increase was West Virginia, which reported a gain of $857,075, or 30.79 per cent. This gain came from an increase in both the brick and tile and the pottery products of the State. Illinois and Texas also showed large gains, over $500,000 in each State. The largest decrease, next to New York, was Pennsylvania, where it was $1,482,990, or 6.81 per cent. New Jersey also showed a loss of over $1,000,000, and Ohio one of $673,335, or 2.17 per cent.

In the following table will be found a comparison of the several varieties of clay products marketed in 1906 and 1907, showing the actual gain or loss in each variety and the percentage of gain or loss in each variety:

*Value of the products of clay in the United States in 1906 and 1907, with increase or decrease.*

| Product. | 1906. | 1907. | Increase (+) and decrease (−) in 1907. | Percentage of increase (+) and decrease (−) in 1907. |
|---|---|---|---|---|
| Common brick | $61,300,696 | $58,785,461 | −$2,515,235 | − 4.10 |
| Vitrified paving brick or block | 7,857,768 | 9,654,282 | + 1,796,514 | +22.86 |
| Front brick | 7,895,323 | 7,329,360 | − 565,963 | − 7.17 |
| Fancy or ornamental brick | 207,119 | 361,243 | + 154,124 | +74.41 |
| Enameled brick | 773,104 | 918,173 | + 145,069 | +18.76 |
| Drain tile | 6,543,289 | 6,864,162 | + 320,873 | + 4.90 |
| Sewer pipe | 11,114,967 | 11,482,845 | + 367,878 | + 3.31 |
| Architectural terra cotta | 5,739,460 | 6,026,977 | + 287,517 | + 5.01 |
| Fireproofing and terra-cotta lumber | 3,652,181 | 3,162,453 | − 489,728 | −13.41 |
| Hollow building tile or blocks | 934,357 | 1,088,165 | + 153,808 | +16.46 |
| Tile (not drain) | 4,634,898 | 4,551,881 | − 83,017 | − 1.79 |
| Stove lining | 743,414 | 627,647 | − 115,767 | −15.57 |
| Fire brick | 14,206,868 | 14,946,045 | + 739,177 | + 5.20 |
| Miscellaneous | 3,988,394 | 3,000,201 | − 988,193 | −24.78 |
| Total brick and tile | 129,591,838 | 128,798,895 | − 792,943 | − .61 |
| Total pottery | 31,440,884 | 30,143,474 | − 1,297,410 | − 4.13 |
| Grand total | 161,032,722 | 158,942,369 | − 2,090,353 | − 1.30 |

This table more than any other shows in concise form the industries in the two years under review, and shows at a glance the total value of the several products, as well as the gain or loss in 1907 compared with 1906. Seven of the items given in the table show a decrease, and 8 show an increase, the grand total showing a decrease of $2,090,353, or 1.30 per cent.

The only important product to show a large gain was vitrified paving brick, which increased in value $1,796,514, or 22.86 per cent. Fire brick made the next largest gain—$739,177, or 5.20 per cent. Next to common brick this is the product of greatest value.

The product showing the largest proportional gain was fancy or ornamental brick, which increased 74.41 per cent. As, however, this is one of the least important branches of the industry and varies much from year to year, no significance can be given to this increase.

The enameled-brick industry, although small, appears to be steadily growing and reached a value in 1907 of nearly $1,000,000, showing a gain of $145,069, or 18.76 per cent.

The use of drain tile seems to be extending, as indicated by the increased value of this product from year to year. In 1907 it gained $320,873 over 1906, or 4.90 per cent. Its principal use is in the Middle Western States, though it is spreading to other portions of the country.

Sewer pipe, the product of third largest value, made a fair gain in 1907, considering the depressed condition of affairs. This gain was $367,878, or 3.31 per cent.

The product of greatest importance, common brick, showed the greatest loss in 1907—$2,515,235, or 4.10 per cent. This decrease was not confined to any one section and can only be accounted for by the general falling off in building.

The front brick, fireproofing, and tile (not drain) industries all showed decreases. As these products are all used in the higher class of structures, their decrease would indicate a falling off in this class of buildings.

The following table shows the products of clay in the United States from 1898 to 1907, inclusive, by varieties of products, together with the total for each year and the number of operating firms reporting:

*Products of clay in the United States, 1898-1907, by varieties.*

| Year. | Number of operating firms reporting. | Common brick. | | | Vitrified paving brick. | | |
|---|---|---|---|---|---|---|---|
| | | Quantity. (thousands). | Value. | Average price per thousand. | Quantity. (thousands). | Value. | Average price per thousand. |
| 1898 | 5,971 | 5,867,415 | $30,980,704 | $5.28 | 474,419 | $4,016,822 | $8.47 |
| 1899 | 6,962 | 7,695,305 | 39,887,522 | 5.18 | 580,751 | 4,750,424 | 8.18 |
| 1900 | 6,475 | 7,140,622 | 38,621,514 | 5.41 | 546,679 | 4,764,124 | 8.71 |
| 1901 | 6,421 | 8,038,579 | 45,503,076 | 5.66 | 605,077 | 5,484,134 | 9.06 |
| 1902 | 6,046 | 8,475,067 | 48,885,869 | 5.77 | 617,192 | 5,744,530 | 9.31 |
| 1903 | 6,034 | 8,463,683 | 50,532,075 | 5.97 | 654,499 | 6,453,849 | 9.86 |
| 1904 | 6,108 | 8,665,171 | 51,768,558 | 5.97 | 735,489 | 7,557,425 | 10.28 |
| 1905 | 5,925 | 9,817,355 | 61,394,383 | 6.25 | 665,879 | 6,703,710 | 10.07 |
| 1906 | 5,857 | 10,027,039 | 61,300,696 | 6.11 | 751,974 | 7,857,768 | 10.45 |
| 1907 | 5,536 | 9,795,698 | 58,785,461 | 6.00 | 876,245 | 9,654,282 | 11.02 |

| Year. | Front brick. | | | Fancy or ornamental brick (value). | Enameled brick (value). | Fire brick (value). | Stove lining (value). | Drain tile (value). |
|---|---|---|---|---|---|---|---|---|
| | Quantity. (thousands). | Value. | Average price per thousand. | | | | | |
| 1898 | 295,833 | $3,572,385 | $12.08 | $358,372 | $279,993 | $6,093,071 | (a) | $3,115,318 |
| 1899 | 438,817 | 4,767,343 | 10.86 | 476,191 | 329,960 | 8,641,882 | $416,235 | 3,682,394 |
| 1900 | 344,516 | 3,864,670 | 11.09 | 289,698 | 323,630 | 9,830,517 | 462,541 | 2,976,281 |
| 1901 | 415,343 | 4,709,737 | 11.34 | 372,131 | 463,709 | 9,870,421 | 423,371 | 3,143,001 |
| 1902 | 458,391 | 5,318,008 | 11.60 | 335,290 | 471,163 | 11,970,511 | 630,924 | 3,506,787 |
| 1903 | 433,016 | 5,402,861 | 12.48 | 328,387 | 569,689 | [a] 14,062,369 | (a) | 4,639,214 |
| 1904 | 434,351 | 5,560,131 | 12.80 | 300,233 | 545,397 | 11,167,972 | (a) | 5,348,555 |
| 1905 | 541,590 | 7,108,092 | 13.12 | 293,907 | 636,279 | 12,735,404 | 645,432 | 5,850,210 |
| 1906 | 617,469 | 7,895,323 | 12.79 | 207,119 | 773,104 | 14,206,868 | 743,414 | 6,543,289 |
| 1907 | 585,943 | 7,329,360 | 12.51 | 361,243 | 918,173 | 14,946,045 | 627,647 | 6,864,162 |

[a] Stove lining not separately classified prior to 1899 is included in fire brick in 1903; in miscellaneous in 1904.

*Products of clay in the United States, 1898–1907, by varieties*—Continued.

| Year. | Sewer pipe (value). | Architectural terra cotta (value). | Fireproofing (value). | Hollow building tile or blocks (value). | Tile, not drain (value). | Miscellaneous (value). | Pottery (value). | Total value. |
|---|---|---|---|---|---|---|---|---|
| 1898 | $3,791,057 | $2,043,325 | $1,900,642 | (a) | $1,746,024 | $2,000,743 | $14,589,224 | $74,487,680 |
| 1899 | 4,560,334 | 2,027,532 | 1,665,066 | (a) | 1,276,300 | 6,065,928 | 17,250,250 | 95,797,370 |
| 1900 | 5,842,562 | 2,372,568 | 1,820,214 | (a) | 2,349,420 | 2,896,036 | 19.798,570 | 96,212,345 |
| 1901 | 6,736,969 | 3,367.982 | 1,860,269 | (a) | 2,867,659 | 2,945,268 | 22,463,860 | 110,211,587 |
| 1902 | 7,174,892 | 3,526.906 | 3,175,593 | (a) | 3,622,863 | 3,678,742 | 24,127,453 | 122,169,531 |
| 1903 | 8,525,369 | 4,672,028 | 2,708,143 | $1,153,200 | 3,505,329 | 3,073,856 | 25,436.052 | 131,062,421 |
| 1904 | 9,187,423 | 4,107,473 | 2,502,603 | 1,126.498 | 3,023,428 | 3,669,282 | 25,158,270 | 131,023,248 |
| 1905 | 10,097,089 | 5,003,158 | 3,004,526 | 1,094,267 | 3,647,726 | 3,564,111 | 27,918,894 | 149.697,188 |
| 1906 | 11,114,967 | 5,739,460 | 3.652,181 | 934,357 | 4,634,898 | 3,988,394 | 31,440,884 | 161,032,722 |
| 1907 | 11,482,845 | 6,026,977 | 3,162,453 | 1,088,165 | 4,551,881 | 3,000,201 | 30,143,474 | 158,942,369 |

[a] Hollow building tile or blocks included in fireproofing prior to 1903.

This table shows the growth of the clay-working industries during ten years. In this decade, the industries have made great progress, both in quality and quantity of ware. Improvements in the processes of manufacture, especially looking toward economies in production, have been made. The total value of the clay products ranged from $74,487,680 in 1898 to $161,032,722 in 1906, 1907 showing a slight falling off. This is a difference between the maximum and minimum of $86,545,042, or 116.19 per cent.

In 1907 the maximum total was reached in only 6 products, viz, vitrified paving brick, enameled brick, fire brick, drain tile, sewer pipe, and architectural terra cotta.

The maximum quantity of common brick was reached in 1906, 10,027,039,000, and the maximum value in 1905, $61,394,383. The average price per thousand ranged from $5.18 in 1899 to $6.25 in 1905.

Front brick reached its maximum quantity and value in 1906, and its highest average value, $13.12, in 1905. Fancy or ornamental brick, although it increased in 1907, reached its maximum in 1899, since which time it has been declining almost continuously. Fireproofing reached its maximum, $3,652,181, in 1906 and declined to $3,162,453 in 1907. Hollow building tile or block has been separately classified only since 1903, when it was reported at its highest value, and has declined steadily since, until 1907 when it showed a slight increase, although it did not reach the value reported for it in 1905. Tile, not drain, reached its maximum in 1906, and showed a decrease in 1907. Pottery in the period covered, showed almost a uniform increase, reaching its maximum in 1906.

The vitrified paving brick product showed its maximum quantity and value, as well as its highest average price in 1907, which indicates the increasing popularity of this material. Its consumption as a structural material seems also to be increasing. The increase of the maximum, in 1907, over the minimum, in 1898, was $5,637,460, or 140.35 per cent. The average price ranged from $8.18 in 1899 to $11.02 in 1907.

Enameled brick, which at the beginning of the decade was valued at $279,993, increased almost steadily to 1907, when it was valued at $918,173, a gain of $638,180, or 227.93 per cent.

The value of the fire-brick product also reached its maximum in 1907, ranging from $6,093,071, the minimum, in 1898 to $14,946,045 in 1907, an increase of $8,852,974, or 145.30 per cent.

Drain tile increased steadily from $2,976,281 in 1900 to $6,864,162 in 1907, an increase of $3,887,881, or 130.63 per cent. Sewer pipe showed a gain and its maximum in 1907. This product has shown a steady growth throughout the entire decade, increasing from $3,791,057 in 1898 to $11,482,845 in 1907, an increase of $7,691,788, or 202.89 per cent.

In 1907 the value of architectural terra cotta reached its maximum of $6,026,977, the minimum being in 1899, from which time until 1907, except in 1904, there was a steady gain. The difference between the minimum and the maximum was $3,999,445, or an increase of 197.26 per cent.

### RANK OF STATES.

In the following table will be found a statement of the rank of the States in the value of clay products, the number of operating firms reporting, the value of the products by States, and the percentage of total value produced by each State in 1906 and 1907:

*Rank of States, value of output, and percentage of total value of clay products in 1906 and 1907.*

| State. | 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|---|
| | Rank. | Number of operating firms reporting. | Value. | Percentage of total product. | Rank. | Number of operating firms reporting. | Value. | Percentage of total product. |
| Ohio | 1 | 784 | $31,014,165 | 19.26 | 1 | 736 | $30,340,830 | 19.09 |
| Pennsylvania | 2 | 514 | 21,774,611 | 13.52 | 2 | 487 | 20,291,621 | 12.77 |
| New Jersey | 3 | 175 | 17,362,269 | 10.78 | 3 | 165 | 16,005,460 | 10.07 |
| Illinois | 5 | 466 | 12,634,181 | 7.85 | 4 | 417 | 13,220,489 | 8.32 |
| New York | 4 | 253 | 13,876,607 | 8.62 | 5 | 247 | 11,772,874 | 7.41 |
| Missouri | 7 | 190 | 6,696,275 | 4.16 | 6 | 172 | 6,898,871 | 4.34 |
| Indiana | 6 | 419 | 7,158,234 | 4.44 | 7 | 392 | 6,858,124 | 4.32 |
| California | 8 | 113 | 4,364,230 | 2.71 | 8 | 118 | 5,740,537 | 3.61 |
| Iowa | 9 | 304 | 3,469,027 | 2.15 | 9 | 276 | 3,728,785 | 2.35 |
| West Virginia | 10 | 65 | 2,783,312 | 1.73 | 10 | 63 | 3,640,387 | 2.29 |
| Kentucky | 11 | 117 | 2,592,423 | 1.61 | 11 | 115 | 2,611,364 | 1.64 |
| Texas | 16 | 139 | 1,969,598 | 1.22 | 12 | 131 | 2,557,561 | 1.61 |
| Georgia | 13 | 99 | 2,400,624 | 1.49 | 13 | 106 | 2,490,237 | 1.57 |
| Kansas | 12 | 66 | 2,432,371 | 1.51 | 14 | 67 | 2,370,058 | 1.49 |
| Massachusetts | 14 | 82 | 2,172,733 | 1.35 | 15 | 80 | 2,128,820 | 1.34 |
| Colorado | 19 | 94 | 1,831,088 | 1.14 | 16 | 88 | 2,041,475 | 1.28 |
| Washington | 24 | 61 | 1,499,884 | .93 | 17 | 63 | 1,921,934 | 1.21 |
| Maryland | 15 | 70 | 2,136,539 | 1.33 | 18 | 63 | 1,886,362 | 1.19 |
| Michigan | 18 | 142 | 1,844,477 | 1.14 | 19 | 136 | 1,817,764 | 1.16 |
| Alabama | 21 | 112 | 1,688,899 | 1.05 | 20 | 100 | 1,754,409 | 1.10 |
| Minnesota | 23 | 109 | 1,603,279 | 1.00 | 21 | 106 | 1,689,933 | 1.06 |
| Tennessee | 22 | 116 | 1,620,226 | 1.01 | 22 | 116 | 1,613,862 | 1.02 |
| Virginia | 17 | 91 | 1,966,078 | 1.22 | 23 | 87 | 1,611,335 | 1.01 |
| Connecticut and Rhode Island | 20 | 42 | 1,747,205 | 1.08 | 24 | 43 | 1,484,592 | .93 |
| North Carolina | 26 | 214 | 1,182,338 | .73 | 25 | 215 | 1,315,822 | .83 |
| Wisconsin | 25 | 147 | 1,227,342 | .76 | 26 | 138 | 1,127,819 | .71 |
| Nebraska | 27 | 98 | 990,708 | .62 | 27 | 89 | 953,432 | .60 |
| Louisiana | 28 | 67 | 900,697 | .56 | 28 | 62 | 928,570 | .58 |
| Mississippi | 29 | 102 | 851,080 | .53 | 29 | 90 | 846,529 | .53 |
| South Carolina | 30 | 63 | 830,481 | .52 | 30 | 63 | 843,379 | .53 |
| Oklahoma | 34 | 47 | [a]540,901 | .34 | 31 | 41 | 664,512 | .42 |
| Maine | 32 | 59 | 680,370 | .42 | 32 | 59 | 658,913 | .42 |
| Utah | 33 | 52 | 634,444 | .39 | 33 | 41 | 633,387 | .40 |
| Oregon | 36 | 63 | 506,192 | .31 | 34 | 63 | 545,839 | .34 |
| Arkansas | 35 | 62 | 532,194 | .33 | 35 | 52 | 536,286 | .34 |
| New Hampshire | 31 | 33 | 726,051 | .45 | 36 | 32 | 510,599 | .32 |
| Florida | 39 | 20 | 289,644 | .18 | 37 | 23 | 354,575 | .22 |
| Idaho and Nevada | 40 | 57 | 282,889 | .18 | 38 | 55 | 327,078 | .21 |
| District of Columbia | 37 | 13 | 335,139 | .21 | 39 | 11 | 322,084 | .20 |
| North Dakota | 41 | 19 | 269,873 | .17 | 40 | 19 | 287,919 | .18 |
| Montana | 38 | 25 | 297,299 | .18 | 41 | 24 | 272,872 | .17 |
| Delaware | 42 | 23 | 237,768 | .15 | 42 | 20 | 190,440 | .12 |
| New Mexico | 43 | 21 | 152,599 | .09 | 43 | 16 | 180,284 | .11 |
| Vermont | 44 | 11 | 112,368 | .07 | 44 | 11 | 109,500 | .07 |
| Arizona | 45 | 18 | 93,694 | .06 | 45 | 17 | 101,462 | .06 |
| Wyoming | 46 | 11 | 74,321 | .05 | 46 | 13 | 88,340 | .06 |
| South Dakota | 47 | 9 | 58,175 | .04 | 47 | 8 | 40,107 | .03 |
| Other States | ...... | ........ | [b]587,820 | .36 | ...... | ........ | [b]594,937 | .37 |
| Total | ...... | 5,857 | 161,032,722 | 100.00 | ...... | 5,536 | 158,942,369 | 100.00 |

[a] Including Indian Territory.

[b] Undistributed pottery products.

This table shows that every State and Territory was a producer of clay products in 1907, which ranged in value from $40,107 in South Dakota, or 0.37 of 1 per cent of the total, to $30,340,830, or 19.09 per cent, in Ohio. Ohio continues to be the leading clay-working State. The difference between the value of the clay products of Ohio and that of the next State, Pennsylvania, is so great—$10,049,209—as to justify the opinion that Ohio will continue to be the leading State for many years. In 1906 Ohio's clay products were valued at $31,014,165, or 19.26 per cent of the total. Pennsylvania was second in both years, reporting products valued at $20,291,621, or 12.77 per cent of the total in 1907, as compared with $21,774,611, or 13.52 per cent of the total in 1906. New Jersey was third in both years, reporting products valued at $16,005,460, or 10.07 per cent of the total, in 1907, and at $17,362,269, or 10.78 per cent of the total, in 1906. Illinois, which was fifth in 1906 became fourth in 1907, exchanging places with New York. Missouri and Indiana also exchanged places, the former becoming sixth and the latter seventh in 1907. California and Iowa retained the same relative ranks in both years—eighth and ninth—and West Virginia was tenth in both years. Texas rose from sixteenth to twelfth; Virginia fell from seventeenth to twenty-third; New Hampshire fell from thirty-first to thirty-sixth, and Washington rose from twenty-fourth to seventeenth. These were the only changes worthy of note.

The first ten States marketed wares valued at $118,497,978, or 74.55 per cent of the total; in 1906 the same States reported wares valued at $121,132,911, or 75.22 per cent of the total. The first five States reported wares valued at $91,631,274, or 57.66 per cent in 1907; in 1906 the products from these States were valued at $96,661,833, or 60.03 per cent.

The number of firms reporting continues to decrease, notwithstanding the large number of plants started each year—a change to be accounted for both by the temporary character of many of the brickyards, which are abandoned at the close of one season, and by the fact that consolidations are still going on, which reduce the number of firms reporting, but not the number of plants. No attempt is made to show the number of yards nor the plants—a considerable number—from which no sales of products were made in 1907.

Ohio had the largest number of reporting firms: 736 in 1907 and 784 in 1906. California was the only one of the first ten States that showed a gain in the number of firms, and in that State the gain was only 5; Georgia also showed a gain of 7, Kansas 1, Washington 2, Connecticut and Rhode Island 1, North Carolina 1, Florida 3, and Wyoming 2. All of the rest of the States showed losses.

## BRICK AND TILE.

### PRODUCTION.

The following tables show the production and value of the building brick and other structural products of clay, together with fire brick, paving brick, and other clay products used in engineering works, the rank of States, and the percentage of total value of each State in 1906 and 1907:

*Brick and tile products of the United States in 1906.*

| Rank. | State. | Common brick. | | | Vitrified paving brick or block. | | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Average price per thousand. | Quantity. | Value. | Average price per thousand. |
| | | *Thousands.* | | | *Thousands.* | | |
| 19 | Alabama | 166,225 | $1,046,986 | $6.30 | (a) | (a) | $11.62 |
| 46 | Arizona | 10,953 | 93,014 | 8.49 | ... | ... | ... |
| 34 | Arkansas | 72,305 | 489,633 | 6.77 | (a) | (a) | 12.00 |
| 8 | California | 278,780 | 1,962,866 | 7.05 | (a) | (a) | 18.49 |
| 17 | Colorado | 120,944 | 787,084 | 6.51 | 6,239 | $74,460 | 11.93 |
| 20 | Connecticut and Rhode Island | 212,648 | 1,503,929 | 7.07 | (a) | (a) | 16.36 |
| 43 | Delaware | 28,004 | 222,628 | 7.95 | ... | ... | ... |
| 36 | District of Columbia | 32,597 | 242,085 | 7.43 | ... | ... | ... |
| 39 | Florida | 42,635 | 285,224 | 6.69 | ... | ... | ... |
| 12 | Georgia | 303,286 | 1,783,988 | 5.88 | (a) | (a) | 13.99 |
| 40 | Idaho and Nevada | 32,757 | 272,174 | 8.31 | (a) | (a) | 26.50 |
| 4 | Illinois | 1,195,210 | 5,719,906 | 4.79 | 122,227 | 1,306,476 | 10.69 |
| 7 | Indiana | 307,076 | 1,778,270 | 5.79 | 45,725 | 502,509 | 10.99 |
| 37 | Indian Territory | 41,913 | 252,608 | 6.03 | 2,169 | 20,231 | 9.33 |
| 9 | Iowa | 168,871 | 1,118,709 | 6.62 | 16,930 | 185,990 | 10.99 |
| 10 | Kansas | 314,371 | 1,376,552 | 4.38 | 78,199 | 658,392 | 8.42 |
| 11 | Kentucky | 142,185 | 881,879 | 6.20 | (a) | (a) | 14.13 |
| 28 | Louisiana | 116,073 | 811,185 | 6.99 | (a) | (a) | 10.00 |
| 32 | Maine | 58,344 | 383,011 | 6.56 | (a) | (a) | 15.04 |
| 18 | Maryland | 204,238 | 1,267,771 | 6.21 | (a) | (a) | 15.60 |
| 14 | Massachusetts | 204,282 | 1,415,864 | 6.93 | ... | ... | ... |
| 16 | Michigan | 206,583 | 1,178,202 | 5.70 | 6,229 | 81,814 | 13.13 |
| 21 | Minnesota | 165,598 | 986,982 | 5.96 | (a) | (a) | 10.68 |
| 29 | Mississippi | 121,107 | 801,420 | 6.62 | ... | ... | ... |
| 6 | Missouri | 257,292 | 1,810,304 | 7.04 | 57,414 | 539,700 | 9.40 |
| 38 | Montana | 24,488 | 203,365 | 8.30 | (a) | (a) | 15.95 |
| 27 | Nebraska | 119,501 | 835,702 | 6.99 | (a) | (a) | 8.00 |
| 31 | New Hampshire | 95,770 | 716,051 | 7.48 | ... | ... | ... |
| 5 | New Jersey | 413,258 | 2,610,686 | 6.32 | (a) | (a) | 14.98 |
| 44 | New Mexico | 16,416 | 115,131 | 7.01 | (a) | (a) | 10.00 |
| 3 | New York | 1,535,579 | 9,205,981 | 6.00 | 10,787 | 163,969 | 15.20 |
| 26 | North Carolina | 166,338 | 1,041,078 | 6.26 | (a) | (a) | 10.00 |
| 41 | North Dakota | 25,972 | 204,188 | 7.86 | ... | ... | ... |
| 2 | Ohio | 550,422 | 3,243,157 | 5.89 | 202,978 | 1,955,360 | 9.63 |
| 42 | Oklahoma | 33,918 | 234,162 | 6.90 | (a) | (a) | 8.00 |
| 35 | Oregon | 45,007 | 341,127 | 7.58 | ... | ... | ... |
| 1 | Pennsylvania | 1,027,541 | 6,586,374 | 6.41 | 93,417 | 996,347 | 10.67 |
| 30 | South Carolina | 128,009 | 748,648 | 5.85 | ... | ... | ... |
| 48 | South Dakota | 6,064 | 54,175 | 8.93 | ... | ... | ... |
| 23 | Tennessee | 169,371 | 1,038,266 | 6.13 | (a) | (a) | 13.00 |
| 15 | Texas | 211,842 | 1,307,199 | 6.17 | (a) | (a) | 10.00 |
| 33 | Utah | 54,903 | 368,151 | 6.71 | ... | ... | ... |
| 45 | Vermont | 13,836 | 85,755 | 6.20 | ... | ... | ... |
| 13 | Virginia | 232,697 | 1,536,312 | 6.60 | ... | ... | ... |
| 22 | Washington | 99,788 | 708,968 | 7.10 | 9,609 | 156,476 | 16.28 |
| 25 | West Virginia | 74,833 | 469,527 | 6.27 | 47,902 | 578,164 | 12.07 |
| 24 | Wisconsin | 170,496 | 1,109,386 | 6.51 | ... | ... | ... |
| 47 | Wyoming | 6,713 | 65,033 | 9.69 | ... | ... | ... |
| | Other States[b] | ... | ... | ... | 52,149 | 637,880 | 12.23 |
| | Total | 10,027,039 | 61,300,696 | 6.11 | 751,974 | 7,857,768 | 10.45 |
| | Per cent of brick and tile products | ... | 47.30 | ... | ... | 6.06 | ... |
| | Per cent of total of clay products | ... | 38.07 | ... | ... | 4.88 | ... |

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[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.

*Brick and tile products of the United States in 1906*—Continued.

| Rank. | State. | Front brick. | | | Fancy or ornamental brick (value). | Drain tile (value). | Sewer pipe (value). | Architectural terra cotta (value). | Fireproofing (value). |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Average price per thousand. | | | | | |
| | | *Thousands.* | | | | | | | |
| 19 | Alabama | (a) | (a) | $11.35 | | $2,285 | (a) | | (a) |
| 46 | Arizona | (a) | (a) | 20.00 | | | | | |
| 34 | Arkansas | 539 | $6,046 | 11.22 | | 3,795 | | | |
| 8 | California | 18,421 | 501,746 | 27.24 | (a) | 30,545 | $827,477 | $254,932 | $98,968 |
| 17 | Colorado | 24,147 | 256,770 | 10.63 | $2,806 | 6,126 | (a) | (a) | (a) |
| 20 | Connecticut and Rhode Island | (a) | (a) | 16.51 | | | | | |
| 43 | Delaware | (a) | (a) | 18.97 | | (a) | | | |
| 36 | District of Columbia | (a) | (a) | 13.05 | | (a) | 30,004 | | (a) |
| 39 | Florida | | | | | (a) | | | |
| 12 | Georgia | 2,094 | 20,747 | 9.91 | | 12,000 | 221,000 | (a) | (a) |
| 40 | Idaho and Nevada | 425 | 10,095 | 23.75 | | | | | |
| 4 | Illinois | 30,022 | 341,298 | 11.37 | 11,635 | 1,052,588 | 587,805 | (a) | 409,171 |
| 7 | Indiana | 35,090 | 395,368 | 11.27 | 4,700 | 1,373,441 | 486,897 | (a) | 323,015 |
| 37 | Indian Territory | 733 | 8,413 | 11.48 | (a) | | | | |
| 9 | Iowa | 8,871 | 101,795 | 11.48 | | 1,721,614 | (a) | | |
| 10 | Kansas | 19,875 | 187,577 | 9.44 | (a) | 19,694 | (a) | | |
| 11 | Kentucky | 11,893 | 109,771 | 9.23 | | 27,359 | (a) | | |
| 28 | Louisiana | (a) | (a) | 12.67 | | (a) | | | |
| 32 | Maine | (a) | (a) | 10.53 | | (a) | (a) | | |
| 18 | Maryland | 2,266 | 31,968 | 14.11 | (a) | 3,315 | | (a) | |
| 14 | Massachusetts | (a) | (a) | 22.17 | (a) | | | (a) | (a) |
| 16 | Michigan | 1,474 | 14,162 | 9.61 | (a) | 314,098 | (a) | | |
| 21 | Minnesota | 7,510 | 98,170 | 13.07 | | 41,779 | (a) | | (a) |
| 29 | Mississippi | 1,051 | 12,549 | 11.94 | | 9,600 | | | |
| 6 | Missouri | 29,019 | 394,563 | 13.59 | 30,689 | 64,063 | 1,208,230 | (a) | (a) |
| 38 | Montana | (a) | (a) | 20.00 | (a) | (a) | (a) | | (a) |
| 27 | Nebraska | (a) | (a) | 13.96 | (a) | (a) | | | |
| 31 | New Hampshire | | | | | | | | |
| 5 | New Jersey | 62,138 | 896,887 | 14.43 | 1,951 | 23,209 | (a) | 1,682,022 | 1,399,233 |
| 44 | New Mexico | (a) | (a) | 12.46 | (a) | | | | |
| 3 | New York | 23,625 | 351,824 | 14.89 | | 153,237 | (a) | 967,987 | 75,631 |
| 26 | North Carolina | 385 | 4,410 | 11.45 | | (a) | (a) | | (a) |
| 41 | North Dakota | 2,732 | 51,100 | 18.70 | | | | | |
| 2 | Ohio | 90,310 | 1,025,590 | 11.36 | 38,218 | 1,520,748 | 3,987,360 | (a) | 793,179 |
| 42 | Oklahoma | 559 | 6,149 | 11.00 | | | | | |
| 35 | Oregon | 1,247 | 33,837 | 27.13 | (a) | 23,424 | (a) | | (a) |
| 1 | Pennsylvania | 151,138 | 1,761,991 | 11.66 | 40,880 | 9,113 | 985,635 | 367,353 | 191,489 |
| 30 | South Carolina | (a) | (a) | 13.74 | | | | | |
| 48 | South Dakota | (a) | (a) | 20.00 | | | | | |
| 23 | Tennessee | 12,077 | 124,031 | 10.27 | 3,663 | 19,719 | (a) | | |
| 15 | Texas | 8,492 | 110,189 | 12.98 | (a) | 3,652 | (a) | | |
| 33 | Utah | 9,917 | 107,255 | 10.82 | (a) | (a) | (a) | | |
| 45 | Vermont | | | | | (a) | | | |
| 13 | Virginia | 25,385 | 392,130 | 15.45 | (a) | 4,805 | | | |
| 22 | Washington | 4,439 | 122,770 | 27.66 | | 13,057 | 313,880 | (a) | 14,792 |
| 25 | West Virginia | (a) | (a) | 15.00 | | (a) | (a) | | |
| 24 | Wisconsin | 5,384 | 52,038 | 9.67 | (a) | 51,143 | | | |
| 47 | Wyoming | 533 | 8,788 | 16.49 | | | | | |
| | Other States[b] | 25,678 | 355,296 | 13.84 | 72,577 | 38,880 | 2,466,673 | 2,467,166 | 346,703 |
| | Total | 617,469 | 7,895,323 | 12.79 | [c]980,223 | 6,543,289 | 11,114,967 | 5,739,460 | 3,652,181 |
| | Per cent of brick and tile products | | 6.09 | | .76 | 5.05 | 8.58 | 4.43 | 2.82 |
| | Per cent of total of clay products | | 4.90 | | .61 | 4.07 | 6.90 | 3.57 | 2.27 |

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[a] Included in "Other States."

[b] Includes all products made by less than three producers in one State.

[c] Including enameled brick valued at $773,104, made in the following States: California, Colorado, Illinois, Maryland, Missouri, New Jersey, New York, Ohio, and Pennsylvania.

*Brick and tile products of the United States in 1906*—Continued.

| Rank. | State. | Hollow building tile or blocks (value). | Tile, not drain (value). | Stove lining (value). | Fire brick. | | | Miscellaneous (value).[a] | Total value. | Percentage of total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Quantity (thousands) | Value. | Average price per thousand. | | | |
| 19 | Alabama | (b) | | | 9,094 | $157,147 | $17.28 | $23,602 | $1,650,903 | 1.27 |
| 46 | Arizona | | | | | | | 180 | 93,094 | .07 |
| 34 | Arkansas | (b) | | | (b) | (b) | 12.12 | 700 | 512,694 | .40 |
| 8 | California | $31,600 | $69,023 | (b) | 14,272 | 347,806 | 24.37 | 68,055 | 4,265,633 | 3.29 |
| 17 | Colorado | (b) | 40,640 | | 14,280 | 278,407 | 19.50 | 75,258 | 1,784,005 | 1.38 |
| 20 | Connecticut and Rhode Island | (b) | | (b) | (b) | (b) | 22.00 | | 1,613,761 | 1.25 |
| 43 | Delaware | | | | (b) | (b) | 20.00 | | 237,768 | .18 |
| 36 | District of Columbia | | | | | | | 30,366 | 335,139 | .26 |
| 39 | Florida | | | | (b) | (b) | 20.00 | | 289,644 | .22 |
| 12 | Georgia | (b) | (b) | | 3,555 | 51,310 | 14.43 | 7,000 | 2,380,367 | 1.84 |
| 40 | Idaho and Nevada | | | | (b) | (b) | 30.00 | | 282,889 | .22 |
| 4 | Illinois | 7,757 | (b) | (b) | 14,646 | 236,032 | 16.12 | 34,330 | 11,651,278 | 8.99 |
| 7 | Indiana | 99,404 | (b) | (b) | 14,074 | 149,351 | 10.61 | 442,145 | 6,224,541 | 4.80 |
| 37 | Indian Territory | | | | (b) | (b) | 17.10 | 17,100 | 299,790 | .23 |
| 9 | Iowa | 162,664 | | | 57 | 930 | 16.32 | 5,084 | 3,411,027 | 2.63 |
| 10 | Kansas | (b) | (b) | | (b) | (b) | 24.73 | 443 | 2,432,371 | 1.88 |
| 11 | Kentucky | (b) | 296,391 | | 50,022 | 898,527 | 17.96 | | 2,425,214 | 1.87 |
| 28 | Louisiana | | | | | | | 29,721 | 894,277 | .69 |
| 32 | Maine | | | | (b) | (b) | 14.99 | 80 | 680,370 | .52 |
| 18 | Maryland | | (b) | $32,200 | 14,278 | 266,980 | 18.70 | 10,000 | 1,763,040 | 1.36 |
| 14 | Massachusetts | | 91,394 | 186,815 | 1,435 | 57,940 | 40.38 | 2,456 | 1,895,199 | 1.46 |
| 16 | Michigan | 4,290 | | (b) | (b) | (b) | 10.05 | | 1,793,367 | 1.38 |
| 21 | Minnesota | 5,991 | | | (b) | (b) | 17.50 | 13,080 | 1,603,279 | 1.24 |
| 29 | Mississippi | (b) | | | | | | 1,200 | 831,769 | .64 |
| 6 | Missouri | 27,717 | (b) | (b) | 70,201 | 1,324,895 | 18.87 | 470,688 | 6,626,775 | 5.11 |
| 38 | Montana | | | | 1,008 | 45,034 | 44.68 | 6,000 | 297,299 | .23 |
| 27 | Nebraska | (b) | | | (b) | (b) | 30.00 | | 990,708 | .76 |
| 31 | New Hampshire | | | | (b) | (b) | 25.00 | | 726,051 | .56 |
| 5 | New Jersey | 85,962 | 1,163,401 | (b) | 39,415 | 954,081 | 24.21 | 858,722 | 10,079,611 | 7.78 |
| 44 | New Mexico | (b) | | | | | | | 152,599 | .12 |
| 3 | New York | 32,428 | 101,319 | 131,908 | 13,605 | 451,783 | 33.21 | 233,411 | 12,008,260 | 9.27 |
| 26 | North Carolina | | | | (b) | (b) | 17.91 | | 1,170,568 | .90 |
| 41 | North Dakota | (b) | | | (b) | (b) | 21.62 | | 269,873 | .21 |
| 2 | Ohio | 365,842 | 1,523,410 | 110,800 | 109,675 | 1,670,630 | 15.23 | 754,712 | 17,023,806 | 13.14 |
| 42 | Oklahoma | | | | | | | | 241,111 | .19 |
| 35 | Oregon | (b) | (b) | | 183 | 5,524 | 30.19 | 20,000 | 506,192 | .39 |
| 1 | Pennsylvania | 51,179 | 389,013 | 203,674 | 374,857 | 6,854,640 | 18.29 | 839,295 | 19,363,794 | 14.94 |
| 30 | South Carolina | | | | 2,169 | 30,564 | 14.09 | | 805,212 | .62 |
| 48 | South Dakota | | | | (b) | (b) | 40.00 | | 58,175 | .04 |
| 23 | Tennessee | (b) | | | 3,473 | 45,379 | 13.07 | 5,000 | 1,405,458 | 1.08 |
| 15 | Texas | | (b) | | 2,484 | 45,557 | 18.34 | 18,137 | 1,860,963 | 1.44 |
| 33 | Utah | | (b) | | 1,654 | 40,512 | 24.49 | 9,680 | 632,344 | .49 |
| 45 | Vermont | | | (b) | | | | | 112,368 | .09 |
| 13 | Virginia | | | | 1,284 | 21,110 | 16.44 | | 1,966,078 | 1.52 |
| 22 | Washington | (b) | (b) | | 1,670 | 46,525 | 27.86 | 7,999 | 1,458,324 | 1.13 |
| 25 | West Virginia | | (b) | | 4,428 | 59,757 | 13.50 | 2,450 | 1,194,757 | .92 |
| 24 | Wisconsin | 810 | | | | | | 1,500 | 1,215,172 | .94 |
| 47 | Wyoming | (b) | | | | | | | 74,321 | .06 |
| | Other States[c] | 58,713 | 960,307 | 78,017 | 9,020 | 166,447 | 18.45 | | (d) | |
| | Total | 934,357 | 4,634,898 | 743,414 | 770,839 | 14,206,868 | 18.43 | 3,988,394 | 129,591,838 | 100.00 |
| | Per cent of brick and tile products | .72 | 3.58 | .57 | | 10.96 | | 3.08 | 100.00 | |
| | Per cent of total of clay products | .58 | 2.88 | .46 | | 8.82 | | 2.47 | 80.48 | |

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[a] Including adobes, aquarium ornaments, art terra cotta, assayers' supplies, boiler and locomotive tile and tank blocks, brick and tile for chemical purposes, burnt clay ballast, chimney pipe, flues and tops, charcoal furnaces, conduits, crucibles, flue and furnace lining, gas logs, glass-house supplies, grave markers, insulators, muffles, oven tile, radial chimney brick and blocks, retorts and settings, rustic stumps, saggers, scorifiers, sewer brick and blocks, sleeves and nozzles, stone pumps, tunnel blocks, vitrified curbing, wall coping, and well brick and tile.

[b] Included in "Other States."

[c] Includes all products made by less than three producers in one State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

*Brick and tile products of the United States in 1907.*

| Rank. | State. | Common brick. | | | Vitrified paving brick or block. | | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Average price per thousand. | Quantity. | Value. | Average price per thousand. |
| | | *Thousands.* | | | *Thousands.* | | |
| 18 | Alabama | 159,315 | $1,004,644 | $6.31 | 13,362 | $183,895 | $13.76 |
| 45 | Arizona | 10,988 | 100,062 | 9.11 | | | |
| 35 | Arkansas | 68,463 | 468,706 | 6.85 | (a) | (a) | 10.00 |
| 8 | California | 339,439 | 2,483,062 | 7.32 | (a) | (a) | 15.79 |
| 14 | Colorado | 118,551 | 803,701 | 6.78 | 3,145 | 37,782 | 12.01 |
| 24 | Connecticut and Rhode Island | 198,414 | 1,240,575 | 6.25 | (a) | (a) | 24.23 |
| 42 | Delaware | 22,047 | 175,410 | 7.96 | | | |
| 39 | District of Columbia | 28,735 | 219,110 | 7.63 | | | |
| 37 | Florida | 51,779 | 343,704 | 6.64 | | | |
| 10 | Georgia | 318,844 | 1,807,148 | 5.67 | (a) | (a) | 12.50 |
| 38 | Idaho and Nevada | 34,034 | 299,403 | 8.80 | (a) | (a) | 25.14 |
| 3 | Illinois | 1,494,807 | 6,499,777 | 4.35 | 126,927 | 1,405,821 | 11.08 |
| 7 | Indiana | 251,766 | 1,509,415 | 6.00 | 46,224 | 548,448 | 11.87 |
| 9 | Iowa | 157,618 | 1,085,383 | 6.89 | 21,686 | 223,193 | 10.29 |
| 13 | Kansas | 263,887 | 1,189,263 | 4.51 | 85,110 | 727,979 | 8.55 |
| 11 | Kentucky | 143,731 | 932,469 | 6.49 | (a) | (a) | 14.27 |
| 28 | Louisiana | 110,386 | 839,236 | 7.60 | | | |
| 32 | Maine | 54,815 | 394,003 | 7.19 | (a) | (a) | 15.00 |
| 21 | Maryland | 166,768 | 1,026,922 | 6.16 | (a) | (a) | 15.00 |
| 16 | Massachusetts | 184,005 | 1,294,918 | 7.04 | | | |
| 17 | Michigan | 200,817 | 1,181,015 | 5.88 | 7,911 | 94,601 | 11.96 |
| 19 | Minnesota | 168,931 | 1,045,874 | 6.19 | (a) | (a) | 12.00 |
| 30 | Mississippi | 114,054 | 783,789 | 6.87 | | | |
| 6 | Missouri | 264,462 | 1,844,255 | 6.97 | 47,807 | 462,341 | 9.67 |
| 41 | Montana | 21,957 | 188,819 | 8.60 | (a) | (a) | 15.01 |
| 27 | Nebraska | 117,276 | 789,170 | 6.73 | 2,900 | 24,600 | 8.48 |
| 36 | New Hampshire | 66,737 | 500,509 | 7.50 | | | |
| 5 | New Jersey | 388,735 | 2,289,883 | 5.89 | (a) | (a) | 13.31 |
| 43 | New Mexico | 15,275 | 116,519 | 7.63 | (a) | (a) | 10.00 |
| 4 | New York | 1,319,416 | 7,056,453 | 5.35 | 18,516 | 253,664 | 13.70 |
| 25 | North Carolina | 174,800 | 1,150,685 | 6.58 | (a) | (a) | 10.00 |
| 40 | North Dakota | 27,058 | 210,212 | 7.77 | | | |
| 2 | Ohio | 495,025 | 3,012,485 | 6.09 | 264,571 | 2,672,600 | 10.10 |
| 31 | Oklahoma | 88,124 | 590,488 | 6.70 | 4,528 | 39,676 | 8.76 |
| 34 | Oregon | 42,857 | 355,912 | 8.30 | (a) | (a) | 20.00 |
| 1 | Pennsylvania | 980,102 | 6,353,799 | 6.48 | 115,729 | 1,232,718 | 10.65 |
| 29 | South Carolina | 125,642 | 760,461 | 6.05 | | | |
| 47 | South Dakota | 4,072 | 40,107 | 9.85 | | | |
| 23 | Tennessee | 170,972 | 1,036,112 | 6.06 | (a) | (a) | 11.98 |
| 12 | Texas | 243,853 | 1,707,812 | 7.00 | (a) | (a) | 10.36 |
| 33 | Utah | 50,982 | 357,010 | 7.00 | | | |
| 44 | Vermont | 12,724 | 83,200 | 6.54 | | | |
| 20 | Virginia | 197,052 | 1,285,374 | 6.52 | | | |
| 15 | Washington | 101,905 | 846,971 | 8.31 | (a) | (a) | 18.22 |
| 22 | West Virginia | 58,102 | 384,007 | 6.61 | 60,681 | 952,060 | 15.69 |
| 26 | Wisconsin | 158,602 | 1,019,522 | 6.43 | (a) | (a) | 8.04 |
| 46 | Wyoming | 7,774 | 78,017 | 10.04 | | | |
| | Other States [b] | | | | 57,148 | 794,904 | 13.91 |
| | Total | 9,795,698 | 58,785,461 | 6.00 | 876,245 | 9,654,282 | 11.02 |
| | Per cent of brick and tile products | | 45.64 | | | 7.50 | |
| | Per cent of total of clay products | | 36.99 | | | 6.07 | |

[a] Included in "Other States."

[b] Includes all products made by less than three producers in one State.

*Brick and tile products of the United States in 1907*—Continued.

| Rank. | State. | Front brick. | | | Fancy or ornamental brick (value). | Drain tile (value). | Sewer pipe (value). | Architectural terra cotta (value). | Fireproofing (value). |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Average price per thousand. | | | | | |
| | | *Thousands.* | | | | | | | |
| 18 | Alabama | (a) | (a) | $13.90 | (a) | (a) | (a) | ...... | (a) |
| 45 | Arizona | (a) | (a) | 13.73 | ...... | ...... | ...... | ...... | ...... |
| 35 | Arkansas | 1,010 | $11,940 | 11.82 | ...... | $5,160 | ...... | ...... | ...... |
| 8 | California | 12,922 | 283,375 | 21.93 | $150,165 | 53,997 | $1,086,916 | $528,623 | $149,959 |
| 14 | Colorado | 24,572 | 254,522 | 10.36 | 46,128 | 19,608 | (a) | (a) | (a) |
| 24 | Connecticut and Rhode Island | (a) | (a) | 15.44 | ...... | ...... | ...... | ...... | ...... |
| 42 | Delaware | (a) | (a) | 19.40 | ...... | (a) | ...... | ...... | ...... |
| 39 | District of Columbia | ...... | ...... | ...... | ...... | (a) | (a) | ...... | (a) |
| 37 | Florida | (a) | (a) | 15.00 | ...... | (a) | ...... | ...... | ...... |
| 10 | Georgia | 1,625 | 16,450 | 10.12 | (a) | 8,050 | 244,000 | (a) | (a) |
| 38 | Idaho and Nevada | 361 | 7,675 | 21.26 | ...... | ...... | ...... | ...... | ...... |
| 3 | Illinois | 20,828 | 266,270 | 12.78 | (a) | 1,031,192 | 662,487 | (a) | 404,265 |
| 7 | Indiana | 36,890 | 437,796 | 11.87 | (a) | 1,437,735 | 487,537 | (a) | 304,151 |
| 9 | Iowa | 8,028 | 96,316 | 12.00 | ...... | 2,011,793 | (a) | ...... | ...... |
| 13 | Kansas | 24,381 | 236,876 | 9.72 | (a) | 15,320 | (a) | (a) | ...... |
| 11 | Kentucky | 7,926 | 86,568 | 10.92 | ...... | 32,723 | (a) | ...... | ...... |
| 28 | Louisiana | (a) | (a) | 11.50 | ...... | (a) | ...... | ...... | ...... |
| 32 | Maine | (a) | (a) | 10.00 | ...... | (a) | (a) | ...... | ...... |
| 21 | Maryland | 1,597 | 19,854 | 12.43 | (a) | 3,190 | ...... | (a) | ...... |
| 16 | Massachusetts | (a) | (a) | 37.13 | (a) | ...... | ...... | (a) | (a) |
| 17 | Michigan | 3,956 | 32,116 | 8.12 | ...... | 289,868 | (a) | ...... | ...... |
| 19 | Minnesota | (a) | (a) | 12.93 | (a) | 49,622 | (a) | ...... | (a) |
| 30 | Mississippi | 1,608 | 20,769 | 12.92 | ...... | 18,200 | ...... | ...... | ...... |
| 6 | Missouri | 30,178 | 387,455 | 12.84 | 33,638 | 72,316 | 1,332,080 | (a) | (a) |
| 41 | Montana | (a) | (a) | 20.00 | (a) | ...... | (a) | ...... | ...... |
| 27 | Nebraska | 7,280 | 100,651 | 13.83 | (a) | (a) | ...... | ...... | ...... |
| 36 | New Hampshire | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | New Jersey | 61,521 | 825,767 | 13.42 | 4,605 | 21,869 | (a) | 1,722,067 | 1,039,808 |
| 43 | New Mexico | 4,047 | 51,362 | 12.69 | ...... | ...... | ...... | ...... | ...... |
| 4 | New York | 12,265 | 198,265 | 16.17 | (a) | 180,818 | (a) | 1,089,278 | 73,064 |
| 25 | North Carolina | 770 | 7,925 | 10.29 | ...... | (a) | (a) | ...... | ...... |
| 40 | North Dakota | 4,067 | 67,482 | 16.59 | (a) | ...... | ...... | ...... | ...... |
| 2 | Ohio | 88,992 | 1,033,434 | 11.61 | 24,468 | 1,433,341 | 3,792,352 | (a) | 691,531 |
| 31 | Oklahoma | 1,752 | 20,990 | 11.98 | ...... | ...... | ...... | ...... | ...... |
| 34 | Oregon | 1,713 | 49,900 | 29.13 | ...... | 25,631 | (a) | ...... | (a) |
| 1 | Pennsylvania | 134,869 | 1,526,565 | 11.32 | 17,727 | 10,386 | 795,991 | 507,116 | 185,127 |
| 29 | South Carolina | 1,850 | 26,750 | 14.46 | ...... | (a) | ...... | ...... | ...... |
| 47 | South Dakota | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 23 | Tennessee | 15,514 | 169,616 | 10.93 | 3,087 | 28,000 | (a) | ...... | ...... |
| 12 | Texas | 11,494 | 153,187 | 13.33 | ...... | (a) | (a) | ...... | ...... |
| 33 | Utah | 14,166 | 167,581 | 11.83 | ...... | (a) | (a) | ...... | ...... |
| 44 | Vermont | (a) | (a) | 10.00 | ...... | (a) | ...... | ...... | ...... |
| 20 | Virginia | 19,989 | 290,411 | 14.53 | 8,903 | 6,250 | ...... | ...... | ...... |
| 15 | Washington | 4,539 | 127,245 | 28.03 | ...... | 17,025 | 482,870 | 94,795 | (a) |
| 22 | West Virginia | (a) | (a) | 15.16 | ...... | 1,211 | ...... | ...... | ...... |
| 26 | Wisconsin | 4,106 | 43,387 | 10.57 | (a) | 49,832 | ...... | ...... | ...... |
| 46 | Wyoming | 728 | 10,323 | 14.18 | ...... | ...... | ...... | ...... | ...... |
| | Other States[b] | 20,399 | 300,534 | 14.73 | 72,522 | 41,025 | 2,508,612 | 2,085,098 | 314,548 |
| | Total | 585,943 | 7,329,360 | 12.51 | [b] 1,279,416 | 6,864,162 | 11,482,845 | 6,026,977 | 3,162,453 |
| | Per cent of brick and tile products | | 5.69 | | .99 | 5.33 | 8.92 | 4.68 | 2.46 |
| | Per cent of total of clay products | | 4.61 | | .81 | 4.32 | 7.22 | 3.79 | 1.99 |

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[a] Included in "Other States."

[b] Includes enameled brick, valued at $918,173, made in the following States: California, Colorado, Illinois, Maryland, New Jersey, and Pennsylvania.

*Brick and tile products of the United States in 1907*—Continued.

| Rank. | State. | Hollow building tile or blocks (value). | Tile, not drain (value). | Stove lining (value). | Fire brick. |  |  | Miscellaneous (value).[a] | Total value. | Per centage of total value. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | Quantity. | Value. | Average price per thousand. |  |  |  |
|  |  |  |  |  | *Thousands.* |  |  |  |  |  |
| 18 | Alabama | (b) | ........ | ........ | 11,026 | $170,711 | $15.48 | $6,900 | $1,726,664 | 1.34 |
| 45 | Arizona | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 101,462 | .08 |
| 35 | Arkansas | (b) | ........ | ........ | (b) | (b) | 12.36 | ........ | 519,336 | .40 |
| 8 | California | $58,246 | $107,492 | (b) | 13,048 | 374,378 | 28.69 | 137,542 | 5,642,699 | 4.38 |
| 14 | Colorado | ........ | (b) | ........ | 19,863 | 430,897 | 21.69 | 75,225 | 1,997,331 | 1.55 |
| 24 | Connecticut and Rhode Island | ........ | ........ | (b) | (b) | (b) | 22.00 | 7,000 | 1,361,476 | 1.06 |
| 42 | Delaware | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 190,440 | .15 |
| 39 | District of Columbia | (b) | ........ | ........ | ........ | ........ | ........ | ........ | 322,084 | .25 |
| 37 | Florida | ........ | ........ | ........ | (b) | (b) | 18.00 | ........ | 354,575 | .28 |
| 10 | Georgia | (b) | (b) | (b) | 5,831 | 82,391 | 14.13 | 13,500 | 2,456,352 | 1.91 |
| 38 | Idaho and Nevada | ........ | ........ | ........ | (b) | (b) | 30.00 | 400 | 327,078 | .25 |
| 3 | Illinois | 25,270 | (b) | (b) | 15,102 | 241,008 | 15.96 | 38,461 | 12,216,323 | 9.48 |
| 7 | Indiana | 110,192 | (b) | ........ | 15,825 | 160,373 | 10.13 | 344,885 | 5,988,970 | 4.65 |
| 9 | Iowa | 176,854 | ........ | ........ | 48 | 795 | 16.56 | 12,200 | 3,709,903 | 2.88 |
| 13 | Kansas | (b) | (b) | ........ | (b) | (b) | 25.08 | 4,535 | 2,370,058 | 1.84 |
| 11 | Kentucky | (b) | 255,054 | ........ | 53,398 | 940,415 | 17.61 | ........ | 2,444,743 | 1.90 |
| 28 | Louisiana | ........ | ........ | ........ | ........ | ........ | ........ | 37,341 | 922,877 | .72 |
| 32 | Maine | ........ | ........ | ........ | (b) | (b) | 15.00 | ........ | 658,913 | .51 |
| 21 | Maryland | ........ | (b) | $31,048 | 12,964 | 242,312 | 18.69 | 10,864 | 1,519,465 | 1.18 |
| 16 | Massachusetts | ........ | 123,220 | 206,042 | 2,019 | 74,115 | 36.71 | 753 | 1,826,076 | 1.42 |
| 17 | Michigan | 6,386 | (b) | ........ | (b) | (b) | 12.00 | 1,500 | 1,786,190 | 1.39 |
| 19 | Minnesota | (b) | ........ | ........ | (b) | (b) | 20.00 | ........ | 1,689,933 | 1.31 |
| 30 | Mississippi | ........ | ........ | ........ | (b) | (b) | 15.00 | 2,500 | 825,408 | .64 |
| 6 | Missouri | 42,673 | (b) | (b) | 76,351 | 1,634,209 | 21.40 | 175,846 | 6,820,684 | 5.30 |
| 41 | Montana | (b) | ........ | ........ | 948 | 35,553 | 37.50 | ........ | 272,872 | .21 |
| 27 | Nebraska | 29,000 | ........ | ........ | ........ | ........ | ........ | ........ | 953,432 | .74 |
| 36 | New Hampshire | ........ | ........ | ........ | (b) | (b) | 31.25 | ........ | 510,599 | .40 |
| 5 | New Jersey | 119,659 | 1,050,085 | (b) | 36,918 | 947,472 | 25.66 | 620,482 | 9,019,834 | 7.00 |
| 43 | New Mexico | ........ | ........ | ........ | (b) | (b) | 25.00 | ........ | 180,284 | .14 |
| 4 | New York | 47,254 | 43,726 | 129,467 | 13,769 | 538,721 | 39.13 | 98,828 | 9,838,376 | 7.64 |
| 25 | North Carolina | ........ | ........ | ........ | (b) | (b) | 17.99 | 5,000 | 1,305,600 | 1.01 |
| 40 | North Dakota | (b) | ........ | ........ | (b) | (b) | 25.87 | ........ | 287,919 | .22 |
| 2 | Ohio | 314,545 | 1,586,174 | 22,416 | 108,197 | 1,668,728 | 15.42 | 550,395 | 16,807,631 | 13.05 |
| 31 | Oklahoma | ........ | ........ | ........ | (b) | (b) | 15.53 | 11,883 | 664,512 | .52 |
| 34 | Oregon | (b) | ........ | ........ | 540 | 22,000 | 40.74 | ........ | 545,839 | .42 |
| 1 | Pennsylvania | 59,646 | 406,269 | 179,218 | 369,956 | 6,907,904 | 18.67 | 784,830 | 18,981,743 | 14.74 |
| 29 | South Carolina | ........ | ........ | ........ | 3,025 | 41,318 | 13.66 | ........ | 829,029 | .64 |
| 47 | South Dakota | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 40,107 | .03 |
| 23 | Tennessee | (b) | ........ | ........ | 3,386 | 40,959 | 12.09 | 6,000 | 1,446,647 | 1.12 |
| 12 | Texas | ........ | ........ | ........ | 4,154 | 75,946 | 18.28 | 16,763 | 2,401,388 | 1.86 |
| 33 | Utah | ........ | (b) | ........ | 1,359 | 34,804 | 25.61 | 11,555 | 633,387 | .49 |
| 44 | Vermont | ........ | ........ | (b) | ........ | ........ | ........ | ........ | 109,500 | .09 |
| 20 | Virginia | ........ | ........ | ........ | (b) | (b) | 15.59 | ........ | 1,611,335 | 1.25 |
| 15 | Washington | (b) | ........ | ........ | 1,506 | 43,940 | 29.18 | 13,660 | 1,891,239 | 1.47 |
| 22 | West Virginia | (b) | 52,429 | ........ | 2,384 | 34,438 | 14.45 | 9,680 | 1,481,255 | 1.15 |
| 26 | Wisconsin | 1,595 | ........ | ........ | ........ | ........ | ........ | 1,653 | 1,118,987 | .87 |
| 46 | Wyoming | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 88,340 | .07 |
|  | Other States[c] | 96,845 | 927,432 | 59,456 | 11,400 | 202,658 | 17.78 | ........ | (d) | ...... |
|  | Total | 1,088,165 | 4,551,881 | 627,647 | 783,017 | 14,946,045 | 19.09 | 3,000,201 | 128,798,895 | 100.00 |
|  | Per cent of brick and tile products | .84 | 3.53 | .49 | ...... | 11.60 | ...... | 2.33 | 100.00 | ...... |
|  | Per cent of total of clay products | .68 | 2.86 | .40 |  | 9.40 | .. | 1.89 | 81.03 | ...... |

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[a] Including adobes, brick for chemical purposes, burnt clay ballast, charcoal furnaces, chimney pipe flues and tops, conduits, crucibles, curbing, gas logs, glass-house supplies, grave and lot markers, insulators, muffles, oven tile, radial chimney brick, block and tile, retorts, scorifiers, sewer brick and blocks, sleeves and nozzles, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than three producers in one State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

These tables show the details, by States, of the production of the coarser clay products in 1906 and 1907. The total value of these products in 1907 was $128,798,895, as compared with $129,591,838 in 1906, a loss of $792,943, or 0.61 of 1 per cent. In 1906 the gain in these products over 1905 was $7,813,544, or 6.42 per cent. In 1905 these products were valued at $121,778,294, so that in 1907 they were greater by $7,020,601, or 5.77 per cent, than in 1905, though less than in 1906.

The common building brick, as its name indicates, is the most widely spread of all clay products, being reported from every State and Territory. In 1907, 9,795,698,000 common brick were reported, valued at $58,785,461, a loss of 231,341,000, or 2.31 per cent, from 1906, when the increase over 1905 was 209,684,000 brick, or 2.13 per cent. The value of the common brick in 1907 was $58,785,461, as compared with $61,300,696 in 1906, a decrease of $2,515,235, or 4.10 per cent. Increases in the output of common brick were reported by 16 out of the 46 States: Arizona, California, Florida, Georgia, Idaho and Nevada, Illinois, Kentucky, Minnesota, Missouri, North Carolina, North Dakota, Oklahoma, Tennessee, Texas, Washington, and Wyoming.

Illinois showed the largest increase, from 1,195,210,000 in 1906 to 1,494,807,000, a gain of 299,597,000, or 25.07 per cent; the value increased from $5,719,906 in 1906 to $6,499,777 in 1907, a gain of $779,871, or 13.63 per cent.

Next to Illinois the State to show the largest increase, as might be expected as a result of the earthquake and fire of 1906, was California, whose common-brick product increased 60,659,000 brick in number and $520,196 in value—a gain of 21.76 per cent in quantity and of 26.50 per cent in value. Texas also made a notable gain—32,011,000 brick and $400,613.

New York, which has been the leading common-brick producer was, in 1907, surpassed by Illinois, which has been second. In 1907 Illinois reported 1,494,807,000 common brick, valued at $6,499,777, or $4.35 per thousand; in 1906 Illinois reported 1,195,210,000 brick, valued at $5,719,906, or $4.79 per thousand, and in 1905, 1,125,024,000 brick, valued at $6,259,232, or $5.56 per thousand. This production in 1907 was 15.26 per cent of the total common-brick output of the entire country in that year. New York's product in 1907 was reported at 1,319,416,000 brick, a decrease from 1906, when the product was 1,535,579,000; this is a loss of 216,163,000, or 14.08 per cent. Of this decrease nearly 86 per cent, or 185,887,000 brick, was in the Hudson River region, as shown elsewhere. The value of New York's common-brick product decreased from $9,205,981 in 1906 to $7,056,453 in 1907—$2,149,528, or 23.35 per cent, of which $1,986,804, or 92.43 per cent, was in the Hudson River region. No State other than Illinois and New York reported as many as 1,000,000,000 common brick in 1907, Pennsylvania being the nearest, with 980,102,000, which made this State rank third in both quantity and value of common brick. If value of product be considered the standard, New York would be first in 1907, her common brick for that year being valued at $7,056,453, as compared with $6,499,777 for Illinois. Ohio retains fourth position in quantity and value, and New Jersey was fifth in quantity, 388,735,000 brick, valued at $2,289,883, or $5.89 per thousand, although California, reporting 339,439,000 brick, valued at

$2,483,062, or $7.32 per thousand, was fifth in value. Other States ranged from Georgia, with 318,844,000 brick, valued at $1,807,148, down to South Dakota, with 4,072,000 brick, valued at $40,107, or $9.85 per thousand.

The average price per thousand for common brick in 1907 ranged from $10.04 in Wyoming to $4.35 in Illinois, the average for the whole country being $6, which was the same as that for Indiana. In 1906 the average per thousand for the whole country was $6.11, the extremes being $4.38 in Kansas and $9.69 in Wyoming. In value common brick constituted 45.64 per cent of all the brick and tile products and 36.99 per cent of all clay products; in 1906 these percentages were, respectively, 47.30 and 38.07.

Vitrified paving brick reported for 1907 numbered 876,245,000, valued at $9,654,282, or $11.02 per thousand; in 1906 the product reported was 751,974,000, valued at $7,857,768, or $10.45 per thousand, a gain in 1907 of 124,271,000, or 16.53 per cent in number, and of $1,796,514, or 22.86 per cent in value. Ohio continues to be the leading producer, reporting 264,571,000 vitrified brick, valued at $2,672,600, or $10.10 per thousand. This is 30.19 per cent of the output for the entire country and 27.68 per cent of the value. In 1906 this State reported nearly 27 per cent of the total product of the country and nearly 25 per cent of the total value. Illinois and Pennsylvania were next in order of production and value, the former reporting 126,927,000 brick, valued at $1,405,821, or $11.08 per thousand, and the latter 115,729,000 brick, valued at $1,232,718, or $10.65 per thousand. Kansas was again fourth in output and fifth in value, reporting 85,110,000 brick, valued at $727,979, or $8.55 per thousand, though West Virginia was fourth in value of output and fifth in quantity, reporting 60,681,000 brick, valued at $952,060, or $15.69 per thousand. In 1906 Ohio reported 202,978,000 vitrified brick, valued at $1,955,360, or $9.63 per thousand; Illinois, 122,227,000, valued at $1,306,476, or $10.69 per thousand; Pennsylvania, 93,417,000, valued at $996,347, or $10.67 per thousand; Kansas, 78,199,000, valued at $658,392, or $8.42 per thousand, and West Virginia 47,902,000, valued at $578,164, or $12.07 per thousand. It will thus be seen that in all of these leading producing States the product and value showed a good increase. The average price per thousand ranged from $25.14 in Idaho and Nevada to $8.04 in Wisconsin. As, however, these are not important producing States, a better idea of the actual range of the average price would be obtained by taking $8.55 in Kansas as one extreme and $15.69 in West Virginia as the other, with the general average for the country at $11.02. In 1906 the average value per thousand for the whole country was $10.45. Vitrified brick in 1907 was 7.50 per cent of the brick and tile product and 6.07 per cent of all the clay products; in 1906 these percentages were, respectively, 6.06 and 4.88.

Front brick reported in 1907 numbered 585,943,000, valued at $7,329,360, or $12.51 per thousand; in 1906, 617,469,000 were reported, valued at $7,895,323, or $12.79 per thousand—a loss of 31,526,000 brick, or 5.11 per cent in quantity, and of $565,963, or 7.17 per cent in value. As in 1906 Pennsylvania, Ohio, and New Jersey were the leading producers of front brick in the order given, the first reporting 134,869,000 brick, valued at $1,526,565, or $11.32 per thousand, the second 88,992,000, valued at $1,033,434, or $11.61 per thousand, and the third 61,521,000, valued at $825,767, or $13.42

per thousand. These three States contributed 48.70 per cent of the total number and 46.19 per cent of the total value of front brick. In 1906 California was fourth in value of product, reporting brick valued at $501,746; in 1907 Indiana was fourth, with a product valued at $437,796. The average price per thousand ranged from $8.12 in Michigan to $37.13 in Massachusetts, with an average for the whole country of $12.51. In 1906 the average ranged from $9.23 in Kentucky to $27.66 in Washington, with a general average of $12.79. In 1907 this product was 5.69 per cent of the value of the brick and tile products and 4.61 per cent of the value of all the clay products. In 1906 these percentages were 6.09 and 4.90, respectively.

The drain-tile industry continues to be one of growing importance, the total value of this product in 1907 being $6,864,162, which is an increase of $320,873, or 4.90 per cent, over 1906. Of this total, the States of Illinois, Indiana, Iowa, Michigan, and Ohio reported drain tile marketed to the value of $6,203,929, or 90.38 per cent of the total. Iowa is the leading State. Indiana and Iowa are the only ones of these leading States that show increases. Drain tile was 5.33 per cent of the brick and tile products and 4.32 per cent of all clay products in 1907; in 1906 the percentages were, respectively, 5.05 and 4.07.

Sewer pipe is another clay product, whose progress was not stopped even by financial disturbances. The value of this product in 1907 was $11,482,845 as compared with $11,114,967 in 1906, a gain of $367,878, or 3.31 per cent. It is produced in 25 States, but in only 8 were there a sufficient number of producers to enable the publication of State totals without revealing individual returns. Of these 8 States, Ohio is the leader, reporting sewer pipe marketed in 1907 to the value of $3,792,352 as compared with $3,987,360 in 1906, a loss of $195,008, or 4.89 per cent. Missouri was the second largest producer, reporting sales valued at $1,332,080, a gain over the report for 1906, and California was the third, displacing Pennsylvania. These three States produced considerably over one-half of the output of the entire country. Sewer pipe was 8.92 per cent of the brick and tile products, and 7.22 of all clay products in 1907; and 8.58 per cent and 6.90 per cent, respectively, in 1906.

Architectural terra cotta may be called one of the highest grades of wares classed in this report as brick and tile. Certainly it requires the highest kind of technical skill in its manufacture; consequently its manufacture may be looked for in but few States. For 1907 it was reported from 14 States, but in only 5 can the totals be given without disclosing individual returns. In 1906 State totals in only 4 cases could be given, and nearly one-half of the total had to be concealed in "Other States." The total product also increased in value in 1907 over 1906 about 5 per cent. The largest producing State is New Jersey, which reported ware valued at $1,722,067, or 28.57 per cent of the total; in 1906 this State reported a product valued at $1,682,022, or 29.31 per cent of the total for the country. This product constituted 4.68 per cent of the brick and tile products and 3.79 per cent of all clay products in 1907; in 1906, these percentages were respectively 4.43 and 3.57. Illinois is one of the leading States in the production of this ware, but owing to there being less than three producers in the State, it is impossible to give a total.

Fireproofing is of a lower grade than architectural terra cotta, and was reported from 16 States; the total from only 7 can be given without disclosing individual returns. Of these 7, New Jersey was the largest producer in 1907, reporting a product valued at $1,039,808, or 32.88 per cent of the total for the country; in 1906 this State's product was valued at $1,399,233, or 38.31 per cent of the total. Ohio was second in both years, reporting 21.87 per cent of the product in 1907. Illinois, third, and Indiana, fourth, maintained their respective places in 1906 and 1907. The value of fireproofing in 1907 was 2.46 per cent of all brick and tile product and 1.99 per cent of all clay products; in 1906 these percentages were 2.82 and 2.27 respectively.

Hollow building tile or block, although not used very extensively in any State, the largest State product being valued at only $314,545, appears to be used in a large number of States, 25 reporting it for 1907. The value of the product increased from $934,357 in 1906 to $1,088,165 in 1907, a gain of 16.46 per cent. Ohio is by far the largest producer, reporting ware valued at $314,545, or 28.91 per cent of the total; in 1906, this State reported 39.15 per cent of the total. Iowa was second and New Jersey third in value of this product in 1907; in 1906 Iowa was second and Indiana third.

Tile, not drain, embraces quite a number of products, such as roofing tile, floor, wall and art tile. These products are used in high-class structures, and with a decrease in these buildings, a decline in these products may be expected. Tile not drain was reported from 17 States in 1907, as against 19 in 1906, but in only 8 States are there a sufficient number of producers to permit the publication of totals. Ohio is the leading producer, reporting a product valued at $1,586,174, or over one-third of the total; and New Jersey was second, reporting a product valued at $1,050,085. These relative ranks were maintained in 1906 and 1905. The value of the tile product was 3.53 per cent of the brick and tile products in 1907 and 2.86 per cent of all clay products; in 1906, these percentages were, respectively, 3.58 and 2.88.

Stove lining was reported from 12 States in 1907 and from 13 in 1906. Owing, however, to the small number of producers in many of these States, it is possible to give totals for only 5. Of these, Massachusetts was the principal producer, with an output valued at $206,042; Pennsylvania was second, reporting a product valued at $179,218. In 1906 these relative positions were reversed. Massachusetts showed an increase in 1907 and Pennsylvania a decrease. New York was third in both years.

Fire brick is one of the most important branches of the clay-working industries. It is widely spread, fire brick being reported from 38 States. The figures given in this report for quantity represent the product reduced to the equivalent of the standard 9-inch fire brick. The quantity so reported for 1907 was 783,017,000 brick, valued at $14,946,045, or $19.09 per thousand, compared with 770,839,000, valued at $14,206,868, or $18.43 per thousand in 1906. This was a gain of 12,178,000 fire brick, or 1.58 per cent in quantity, and of $739,177, or 5.20 per cent in value. Pennsylvania is by far the largest producer, reporting 369,956,000 fire brick, valued at $6,907,904, or $18.67 per thousand; for 1906 this State reported 374,857,000 fire brick, valued at $6,854,640, or $18.29 per thousand, a loss in 1907 of 4,901,000 brick in quantity but a gain of $53,264 in value. Pennsylvania alone, in 1907, produced 47.25 per cent of the fire brick of the whole country and 46.22 per cent of the total value. Ohio was second in both years, reporting 108,197,000 fire brick in 1907, valued at

$1,668,728, or $15.42 per thousand, against 109,675,000 fire brick in 1906, valued at $1,670,630, or $15.23 per thousand—a small loss in 1907 in both quantity and value, though the average price per thousand in 1907 was slightly higher than that for 1906. Missouri was third in 1906 and 1907, reporting increases in both quantity and value. Kentucky was fourth in quantity in 1907 and fifth in value, and New Jersey was fifth in quantity and fourth in value. The other States were comparatively small producers, New York reporting the product of next largest value, $538,721, though the quantity was small, 13,769,000 fire brick, the average value per thousand being very high, $39.13. The range in average value per thousand was from $10.13 in Indiana to $40.74 in Oregon, with a general average of $19.09. As in other varieties of brick, these extremes are in States of small importance as producers. Fire brick composed in 1907 11.60 per cent of the value of the brick and tile products and 9.40 per cent of all clay products; in 1906 these percentages were, respectively, 10.96 and 8.82.

Ohio is the leading State in the clay-working industries as a whole, but when the coarser products are considered—brick and tile of this classification—Pennsylvania is the leading State, its output being valued in 1907 at $18,981,743, or 14.74 per cent of all brick and tile products, and in 1906 at $19,363,794, or 14.94 per cent of the total—a loss in 1907 of $382,051, or 1.97 per cent. Ohio ranked second, with products valued at $16,807,631, or 13.05 per cent of the total brick and tile products; in 1906 Ohio's brick and tile products were valued at $17,023,806, or 13.14 per cent of the total—a decrease of $216,175, or 1.27 per cent. Illinois was third in 1907, displacing New York, which became fourth. The product reported from Illinois in 1907 was valued at $12,216,323, or 9.48 per cent of the total, as compared with $11,651,278, or 8.99 per cent of the total, a gain of $565,045, or 4.85 per cent. The product reported from New York in 1907 was valued at $9,838,376, or 7.64 per cent of the total; in 1906 the product of this State was valued at $12,008,260, or 9.27 per cent of the whole—a decrease of $2,169,884, or 18.07 per cent. New Jersey was fifth in both years, reporting 7 per cent of the total brick and tile products in 1907, and 7.78 per cent in 1906. Her products were valued respectively in 1907 and 1906 at $9,019,834 and $10,079,611. There were no other changes in 1907 in relative rank of States until tenth place is reached, when Georgia displaced Kansas. Texas rose from fifteenth place in 1906 to twelfth in 1907, and Kansas fell from tenth in 1906 to thirteenth in 1907. Colorado which was seventeenth in 1906 became fourteenth in 1907. Washington rose from twenty-second in 1906 to fifteenth in 1907.

In 1906 there were 7 States contributing over $5,000,000 each; in 1907 there were 8 States—Pennsylvania, Ohio, Illinois, New York, New Jersey, Missouri, Indiana, and California, and the total output of these States was $85,316,260, or 66.24 per cent of the total value of the brick and tile products.

### HUDSON RIVER REGION.

The Hudson River district has been for years the largest brick-making center in this country, and probably in the world. Ten counties are included in this region, 9 in New York and 1 in New Jersey. As the market for the product of this region is New York City and its environs, the brick business naturally follows the course of building in the metropolis. The building operations of Greater New York in 1905, when buildings were erected at a cost of over $250,000,000, naturally caused a great demand for the products of the Hudson River brickyards. With this great demand, the prices rose correspondingly until the price of common brick of this region was nearly doubled, and the output, as compared with only a few years previous, was more than 50 per cent greater and the value nearly two and one-half times as great. The year 1906 showed a falling off in both product and price of brick in this region, and 1907 showed a still further decrease, the figures being approximately the same as those of 1904. The cause in both years was the falling off in building in Greater New York.

The total number of brick marketed from these 10 counties by 132 firms in 1907 was 1,064,892,000, valued at $5,515,585, or $5.18 per thousand, as compared with 1,274,372,000, valued at $7,672,639, or $6.02 per thousand in 1906, a decrease of 209,480,000 brick, or 16.44 per cent in quantity, and of $2,157,054, or 28.11 per cent in the value. Compared with 1904, the year before the extraordinary increase in production of this region, the marketed product of 1907 was greater by 77,248,000 brick, though the value of the product was $294,529, or 5.07 per cent less than that of 1904, the average price per thousand being $5.88 in 1904 and $5.18 in 1907.

New York's portion of this region contributed about 95 per cent of both quantity and value. This product of 1,012,513,000 common brick, which was a decrease of 185,887,000, or 15.51 per cent, from 1906 constituted 76.74 per cent of New York's total output of common brick, and was greater than the common brick output of any other State except Illinois, although Pennsylvania nearly approached it with 980,102,000 brick. The value of New York's portion of the product of this region was $5,241,237, a decrease of $1,986,804, or 27.49 per cent, from 1906. This value was exceeded in 1907 by both Illinois and Pennsylvania. In 1906 New York's portion exceeded by $641,667 the value of Pennsylvania's product of common brick, that State being next to New York the largest producer of that variety of brick. In 1906 the value of clay products in only 5 States exceeded the value of the product of New York's portion of this region, but in 1907 this value was exceeded by 8 States.

Of the counties included in this region, Ulster had the largest product in 1907, 235,584,000 brick; Rockland was second with 233,562,000 brick; in value of product, however, Rockland was first, reporting $1,272,455, or $5.45 per thousand, compared with Ulster's $1,217,613, or $5.17 per thousand. In 1906 Rockland was first with 287,538,000 brick, valued at $1,823,371, and Ulster second with 261,970,000 brick, valued at $1,391,013. Orange and Dutchess counties maintained their respective places in production, third and fourth, the former reporting 148,103,000 brick and the latter 135,469,000 brick in 1907, as compared with 182,103,000 brick and 154,456,000 brick, respectively, in 1906.

The average value per thousand for the whole region was $5.18 in 1907, $6.02 in 1906, and $6.99 in 1905. In New York's portion in 1907 the average price ranged from $5.55 per thousand in Westchester County to $4.56 in Columbia, with a general average of $5.18 in 1907. In 1906 the average for the whole New York region was $6.03 and in 1905 it was $7.

The conditions in Bergen County, N. J., were similar to those in the New York portion of the region, and the product showed a large loss, declining from 75,972,000 brick in 1906 to 52,379,000 brick in 1907, a loss in quantity of 23,593,000 brick, or 31.05 per cent, and in value of $170,250, or 38.29 per cent. The average price per thousand in New Jersey was slightly above the general average in 1907 and below it in 1906.

The number of firms reporting also decreased from 135 in 1906 to 132 in 1907; of this loss 2 firms were in New Jersey and 1 in New York. The largest number of firms that have reported from this region was 135 in 1906. This number was due no doubt to the attractive prices received for brick during 1905.

*Production of common brick in the Hudson River district from Cohoes to New York City in 1906 and 1907, by counties.*

| County. | 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of firms reporting. | Quantity (thousands). | Value. | Average price per thousand. | Number of firms reporting. | Quantity (thousands). | Value. | Average price per thousand. |
| Albany | 12 | 72,936 | $454,392 | $6.23 | 11 | 62,685 | $306,316 | $4.89 |
| Columbia | 6 | 79,500 | 539,850 | 6.79 | 6 | 82,937 | 378,576 | 4.56 |
| Dutchess | 16 | 154,456 | 883,607 | 5.72 | 16 | 135,469 | 727,313 | 5.37 |
| Greene | 6 | 61,467 | 370,131 | 6.02 | 5 | 40,289 | 191,676 | 4.76 |
| Orange | 10 | 182,103 | 1,130,683 | 6.21 | 10 | 148,103 | 740,372 | 5.00 |
| Rensselaer | 7 | 24,900 | 143,550 | 5.77 | 7 | 17,681 | 95,236 | 5.39 |
| Rockland | 32 | 287,538 | 1,823,371 | 6.34 | 33 | 233,562 | 1,272,455 | 5.45 |
| Ulster | 24 | 261,970 | 1,391,013 | 5.31 | 25 | 235,584 | 1,217,613 | 5.17 |
| Westchester | 10 | 73,530 | 491,444 | 6.68 | 9 | 56,203 | 311,680 | 5.55 |
| Total for New York | 123 | 1,198,400 | 7,228,041 | 6.03 | 122 | 1,012,513 | 5,241,237 | 5.18 |
| Bergen County, N. J | 12 | 75,972 | 444,598 | 5.85 | 10 | 52,379 | 274,348 | 5.24 |
| Total | 135 | 1,274,372 | 7,672,639 | 6.02 | 132 | 1,064,892 | 5,515,585 | 5.18 |

## POTTERY.

### INTRODUCTION.

The pottery industry of the United States seems to have suffered to a larger extent from the financial depression of 1907 than did the other branches of the clay-working industries, as is shown by the figures hereinafter given. The total value of the pottery products of the country as reported to this office was $30,143,474 as compared with $31,440,884, a decrease of $1,297,410, or 4.13 per cent; in 1906 the increase over 1905 was $3,521,990, or 12.62 per cent. Compared with 1905, however, the 1907 figures are much larger, $2,224,580, or 7.97 per cent. The value of the pottery products of 1907 is more than twice as great as it was in 1898—$14,589,224; so it is only by comparison with 1906 that 1907 was small. The imports of pottery showed the small increase in 1907 over 1906, $354,510, or 2.68 per cent, compared with the increase in 1906 over 1905 of $1,255,040, or 10.48 per cent. At present the domestic production is nearly three-fourths of the consumption. Its proportion to consumption declined slightly in 1907, but its trend in previous years has been steadily upward, and no doubt it will continue to increase until eventually the domestic potter will supply the demand for the higher grades of his wares just as he now supplies the lower grades. The general tendency in quality of ware of the domestic pottery is undoubtedly upward, and the fact that there was a marked advance made during 1907 in the production of a distinctively American china augurs well for the future of the industry. The potters, some of them at least, seem to be making every effort to remove the stigma that has rested on "American pottery." That they can and will do this no one doubts, and it is only a question of time when our wares of highest grade will be sought by the discriminating purchaser as are the foreign wares to-day.

## PRODUCTION.

In the following tables will be found statistics of the production of pottery in the United States in 1906 and 1907, the former year being given for comparative purposes:

*Value of pottery products in 1906, by varieties of products, by States.*

| Rank of State. | State. | Number of active firms. | Red earthenware. | Stoneware and yellow and Rockingham ware. | C. C. ware, white granite, semi-porcelain ware, and semivitreous porcelain ware. | China, bone china Delft, and Belleek ware. |
|---|---|---|---|---|---|---|
| 20 | Alabama | 25 | $2,620 | $35,376 | | |
| 23 | Arkansas | 3 | (a) | (a) | | |
| 14 | California | 15 | 37,781 | 25,199 | | |
| 18 | Colorado | 6 | 9,077 | 26,266 | | |
| 12 | Connecticut | 4 | 41,544 | (a) | | |
| | District of Columbia | | (a) | | | |
| | Florida | | (a) | (a) | | |
| 22 | Georgia | 17 | 5,345 | 14,912 | | |
| 6 | Illinois | 23 | 37,543 | 897,650 | (a) | |
| 7 | Indiana | 18 | 6,550 | 66,774 | (a) | |
| 16 | Iowa | 6 | 10,100 | (a) | | |
| | Kansas | | | (a) | | |
| 11 | Kentucky | 11 | 26,637 | 140,572 | | |
| 27 | Louisiana | 3 | (a) | | | |
| | Maine | | | (a) | | |
| 8 | Maryland | 10 | 12,733 | (a) | $352,000 | |
| 9 | Massachusetts | 14 | 171,160 | 18,210 | (a) | |
| 17 | Michigan | 6 | 43,510 | | | |
| | Minnesota | | | (a) | | |
| 24 | Mississippi | 8 | 2,004 | 17,307 | | |
| 15 | Missouri | 11 | 4,429 | 65,071 | | |
| | Montana | | (a) | (a) | | |
| | New Hampshire | | | | | |
| 2 | New Jersey | 57 | 22,068 | 54,725 | 1,436,246 | $1,065,986 |
| 4 | New York | 25 | 34,034 | 70,131 | (a) | 657,817 |
| 26 | North Carolina | 28 | 713 | 11,057 | | |
| 1 | Ohio | 126 | 206,258 | 1,581,732 | 9,735,072 | (a) |
| | Oregon | | (a) | (a) | | |
| 3 | Pennsylvania | 46 | 165,073 | 312,150 | 845,366 | (a) |
| 21 | South Carolina | 8 | 11,701 | 13,568 | | |
| 10 | Tennessee | 11 | (a) | 163,900 | | |
| 13 | Texas | 21 | 10,045 | 98,590 | | |
| 28 | Utah | 3 | 2,100 | | | |
| | Virginia | | | | | |
| 19 | Washington | 4 | 5,500 | 36,060 | | |
| 5 | West Virginia | 13 | | 23,200 | 1,047,770 | |
| 25 | Wisconsin | 4 | 11,470 | | | |
| | Other States[b] | | 29,267 | 521,434 | 736,049 | 63,973 |
| | Total | [c]540 | 909,262 | 4,193,884 | 14,152,503 | 1,787,776 |
| | Per cent of pottery products | | 2.89 | 13.34 | 45.01 | 5.69 |
| | Per cent of total clay products | | .56 | 2.60 | 8.79 | 1.11 |
| | Number of firms reporting each variety | | 186 | 255 | 77 | 14 |

[a] Included in "Other States."

[b] Includes all products made by less than three producers in one State. The total of "Other States" is distributed among the States to which it belongs.

[c] Includes fourteen firms not distributed.

*Value of pottery products in 1906, by varieties of products, by States*—Continued.

| Rank of State. | State. | Sanitary ware. | Porcelain electrical supplies. | Miscellaneous.[a] | Total. | Percentage of total. |
|---|---|---|---|---|---|---|
| 20 | Alabama |  |  |  | $37,996 | 0.12 |
| 23 | Arkansas |  |  | $1,500 | 19,500 | .06 |
| 14 | California | (b) |  | 18,447 | 98,597 | .31 |
| 18 | Colorado |  |  | 11,740 | 47,083 | .15 |
| 12 | Connecticut |  | (b) | 20,000 | 133,444 | .42 |
|  | District of Columbia |  |  |  | (c) |  |
|  | Florida |  |  |  | (c) |  |
| 22 | Georgia |  |  |  | 20,257 | .07 |
| 6 | Illinois |  | (b) | 36,876 | 982,903 | 3.13 |
| 7 | Indiana | $435,000 | (b) |  | 933,693 | 2.97 |
| 16 | Iowa |  |  | 3,400 | 58,000 | .19 |
|  | Kansas |  |  |  | (c) |  |
| 11 | Kentucky |  |  |  | 167,209 | .53 |
| 27 | Louisiana |  |  | 5,920 | 6,420 | .02 |
|  | Maine |  |  |  | (c) |  |
| 8 | Maryland |  |  | 4,000 | 373,499 | 1.19 |
| 9 | Massachusetts |  | (b) | 24,033 | 277,534 | .88 |
| 17 | Michigan |  |  | 7,600 | 51,110 | .16 |
|  | Minnesota |  |  |  | (c) |  |
| 24 | Mississippi |  |  |  | 19,311 | .06 |
| 15 | Missouri |  |  |  | 69,500 | .22 |
|  | Montana |  |  |  | (c) |  |
|  | New Hampshire |  |  | (b) | (c) |  |
| 2 | New Jersey | 3,742,045 | $783,549 | 178,039 | 7,282,658 | 23.16 |
| 4 | New York | (b) | 663,886 | 46,944 | 1,868,347 | 5.94 |
| 26 | North Carolina |  |  |  | 11,770 | .04 |
| 1 | Ohio | 285,000 | 1,100,979 | 1,021,020 | 13,990,359 | 44.50 |
|  | Oregon |  |  |  | (c) |  |
| 3 | Pennsylvania | 186,560 |  | 897,993 | 2,410,817 | 7.67 |
| 21 | South Carolina |  |  |  | 25,269 | .08 |
| 10 | Tennessee |  |  | 50,000 | 214,768 | .68 |
| 13 | Texas |  |  |  | 108,635 | .35 |
| 28 | Utah |  |  |  | 2,100 | .01 |
|  | Virginia |  | (b) | (b) | (c) |  |
| 19 | Washington |  |  |  | 41,560 | .13 |
| 5 | West Virginia | 387,000 | (b) | 85,000 | 1,588,555 | 5.05 |
| 25 | Wisconsin |  |  | 700 | 12,170 | .04 |
|  | Other States[d] | 62,705 | 289,870 | 47,653 | [e] 587,820 | 1.87 |
|  | Total | 5,098,310 | 2,838,284 | 2,460,865 | 31,440,884 | 100.00 |
|  | Per cent of pottery products | 16.21 | 9.03 | 7.83 | 100.00 |  |
|  | Per cent of total clay products | 3.17 | 1.76 | 1.53 | 19.52 |  |
|  | Number of firms reporting each variety | 35 | 35 |  |  |  |

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[a] Including art and chemical pottery, bread toasters, craquelle porcelain, faience, Hampshire pottery, handmade tile, hanging baskets, jardinieres and pedestals, Pewabic pottery, pins, stilts, and spurs for potters' use; porcelain doorknobs, shuttle eyes, thread guides and filter tubes, porcelain hardware trimmings, porcelain-lined cooking ware, porcelain teeth, stems, and mouth rings; stove crocks, Teco pottery, tobacco pipes, toy marbles, turpentine cups, umbrella stands, and vases.

[b] Included in "Other States."

[c] Included in [e] ($587,820).

[d] Includes all products made by less than three producers in one State. The total of "Other States" is distributed among the States to which it belongs.

[e] Made up of State totals of District of Columbia, Florida, Kansas, Minnesota, Montana, New Hampshire, Oregon, and Virginia.

*Value of pottery products in 1907, by varieties of products, by States.*

| Rank of State. | State. | Number of active firms. | Red earthenware. | Stoneware and yellow and Rockingham ware. | C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware. | China, bone china, Delft, and Belleek ware. |
|---|---|---|---|---|---|---|
| 20 | Alabama | 22 | $7,530 | $20,215 | | |
| 23 | Arkansas | 3 | (a) | 15,200 | | |
| 14 | California | 13 | 42,856 | 39,382 | | |
| 17 | Colorado | 6 | 1,931 | 35,644 | | |
| 13 | Connecticut | 4 | 31,616 | (a) | | |
| | District of Columbia | | (a) | | | |
| | Florida | | (a) | (a) | | |
| 18 | Georgia | 15 | 18,440 | 15,445 | | |
| 6 | Illinois | 24 | 37,045 | 898,267 | (a) | |
| 7 | Indiana | 18 | 5,075 | 45,579 | (a) | |
| 22 | Iowa | 6 | 8,250 | (a) | | |
| | Kansas | | | (a) | | |
| 11 | Kentucky | 11 | 27,546 | 139,075 | | |
| 27 | Louisiana | 3 | (a) | | | |
| | Maine | | | (a) | | |
| 8 | Maryland | 10 | 12,895 | (a) | $348,890 | |
| 9 | Massachusetts | 16 | 166,978 | 17,693 | (a) | |
| 16 | Michigan | 6 | 54,474 | | | |
| | Minnesota | | (a) | (a) | | |
| 21 | Mississippi | 7 | 865 | 20,256 | | |
| 15 | Missouri | 12 | 3,289 | 69,323 | | |
| | Montana | | (a) | | | |
| | New Hampshire | | | | | |
| 2 | New Jersey | 55 | 21 067 | (a) | 1,225,691 | $1,135,885 |
| 4 | New York | 24 | 32 896 | 87,471 | (a) | 746,634 |
| 25 | North Carolina | 24 | 2,382 | 7,840 | | |
| 1 | Ohio | 118 | 142,042 | 1,648,213 | 9,419,960 | (a) |
| | Oregon | | (a) | (a) | | |
| 5 | Pennsylvania | 40 | 164,096 | 380,361 | 531,634 | (a) |
| 24 | South Carolina | 6 | 4,450 | 9,900 | | |
| 10 | Tennessee | 13 | 6,185 | 111,030 | | |
| 12 | Texas | 19 | 6,759 | 149,414 | | |
| | Utah | | (a) | | | |
| | Virginia | | | | | |
| 19 | Washington | 4 | 2,500 | 28,195 | | |
| 3 | West Virginia | 12 | | (a) | 1,651,732 | |
| 26 | Wisconsin | 3 | 8,832 | | | |
| | Other States[b] | | 35,466 | 542,098 | 735,773 | 48,150 |
| | Total | [c]509 | 845,465 | 4,280,601 | 13,913,680 | 1,930,669 |
| | Per cent of pottery products | | 2.80 | 14.20 | 46.16 | 6.41 |
| | Per cent of total clay products | | .53 | 2.09 | 8.75 | 1.22 |
| | Number of firms reporting each variety | | 193 | 219 | 68 | 16 |

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[a] Included in "Other States."

[b] Includes all products made by less than three producers in one State. The total of "Other States" is distributed among the States to which it belongs.

[c] Includes fifteen firms not distributed.

*Value of pottery products in 1907, by varieties of products, by States*—Continued.

| Rank of State. | State. | Sanitary ware. | Porcelain electrical supplies. | Miscellaneous.[a] | Total. | Percentage of total. |
|---|---|---|---|---|---|---|
| 20 | Alabama |  |  |  | $27,745 | 0.09 |
| 23 | Arkansas |  |  |  | 16,950 | .06 |
| 14 | California | (b) |  | $2,800 | 97,838 | .32 |
| 17 | Colorado |  |  | 6,569 | 44,144 | .15 |
| 13 | Connecticut |  | (b) | 18,500 | 123,116 | .41 |
|  | District of Columbia |  |  |  | (c) |  |
|  | Florida |  |  |  | (c) |  |
| 18 | Georgia |  |  |  | 33,885 | .11 |
| 6 | Illinois |  | (b) | 57,054 | 1,004,166 | 3.33 |
| 7 | Indiana | $400,000 | (b) | 500 | 869,154 | 2.88 |
| 22 | Iowa |  |  | 3,500 | 18,882 | .06 |
|  | Kansas |  |  |  | (c) |  |
| 11 | Kentucky |  |  |  | 166,621 | .55 |
| 27 | Louisiana |  |  | 5,293 | 5,093 | .02 |
|  | Maine |  |  |  | (c) |  |
| 8 | Maryland |  |  | 3,500 | 366,897 | 1.22 |
| 9 | Massachusetts |  | (b) | 23,100 | 302,744 | 1.00 |
| 16 | Michigan |  |  | 7,100 | 61,574 | .20 |
|  | Minnesota |  |  |  | (c) |  |
| 21 | Mississippi |  |  |  | 21,121 | .07 |
| 15 | Missouri |  |  | 5,575 | 78,187 | .26 |
|  | Montana |  |  |  | (c) |  |
|  | New Hampshire |  |  | (b) | (c) |  |
| 2 | New Jersey | 3,615,685 | $744,068 | 186,809 | 6,985,626 | 23.18 |
| 4 | New York | (b) | 626,032 | 51,582 | 1,934,498 | 6.42 |
| 25 | North Carolina |  |  |  | 10,222 | .03 |
| 1 | Ohio | 226,000 | 933,256 | 1,130,678 | 13,533,199 | 44.90 |
|  | Oregon |  |  |  | (c) |  |
| 5 | Pennsylvania | 192,854 |  | 25,833 | 1,309,878 | 4.35 |
| 24 | South Carolina |  |  |  | 14,350 | .05 |
| 10 | Tennessee |  |  | 50,000 | 167,215 | .56 |
| 12 | Texas |  |  |  | 156,173 | .52 |
|  | Utah |  |  |  | (c) |  |
|  | Virginia |  | (b) | (b) | (c) |  |
| 19 | Washington |  |  |  | 30,695 | .10 |
| 3 | West Virginia | 378,000 | (b) | 78,985 | 2,159,132 | 7.16 |
| 26 | Wisconsin |  |  |  | 8,832 | .03 |
|  | Other States[d] | 50,683 | 310,415 | 38,688 | [e] 594,937 | 1.97 |
|  | Total | 4,863,222 | 2,613,771 | 1,696,066 | 30,143,474 | 100.00 |
|  | Per cent of pottery products | 16.13 | 8.67 | 5.63 | 100.00 |  |
|  | Per cent of total clay products | 3.06 | 1.65 | 1.07 | 18.97 |  |
|  | Number of firms reporting each variety | 36 | 36 | 75 |  |  |

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[a] Including art and chemical pottery, craquelle porcelain, faience, garden vases, Grueby, Hampshire, and Teco pottery, handmade tile, hanging baskets, incandescent mantle supplies, jardinieres and pedestals, pins, stilts, and spurs for potters' use; porcelain doorknobs and filter tubes, porcelain hardware trimmings, statuettes, stove crocks, tobacco pipes, toy marbles, turpentine cups, and umbrella stands.

[b] Included in "Other States."

[c] Included in [e] ($594,937).

[d] Includes all products made by less than three producers in one State. The total of "Other States" is distributed among the States to which it belongs.

[e] Made up of State totals of District of Columbia, Florida, Kansas, Maine, Minnesota, Montana, New Hampshire, Oregon, Utah, and Virginia.

As in former years, pottery products, except earthenware and stoneware, were reported from but few States. White ware, or what is known as "general ware," was produced, as in 1906, in 9 States, though it seems possible in view of the high freight rates and the accessibility of suitable material in the Western States that general ware potteries may be established in that section of the country before long. Sanitary ware was reported from 7 States and porcelain electrical supplies from 9. Where there are less than 3 producers in any State, the total for that State is not given. This is done in order to prevent the disclosing of individual returns; hence some of these columns have figures for only a few States, the others, which are indicated by a footnote, being grouped under "Other States."

Red earthenware, the commonest of pottery products, being made from almost any red-brick clay, was reported from 32 States, Minnesota, which reported none in 1906, entering this column in 1907. Massachusetts, which was second in value of this ware in 1906, was first in 1907, reporting ware to the value of $166,978. Even this was a loss of $4,182. In 1905 this State was first, reporting ware valued at $185,074. Pennsylvania, which was third in 1906, reporting ware valued at $165,073, was second in 1907, and Ohio, which was first in 1906, became third in 1907. The total value of this ware in 1907 was $845,465, as compared with $909,262 in 1906, a loss of $63,797, or 7.02 per cent. The total value for 1907 was greater by $64,828, or 8.30 per cent, than in 1905, when it was $780,637. This product was reported by 186 producers in 1906 and by 193 in 1907. In 1906 it constituted 2.89 per cent of all pottery products and 2.80 per cent in 1907.

Stoneware and yellow and Rockingham wares were reported from 29 States in 1907 and from 30 States in 1906, Montana reporting a product in 1906 and none in 1907. Ohio was the leading producer, reporting wares valued at $1,648,213, or 38.5 per cent of the whole. This was an increase of $66,481 over 1906. Illinois was second and Pennsylvania third in both 1906 and 1907. The total value of these products was $4,280,601 in 1907 and $4,193,884 in 1906, a gain in 1907 of $86,717, or 2.07 per cent. The number of firms reporting decreased from 255 in 1906 to 219 in 1907. In point of value, these wares are one of the three most important classes, being 14.20 per cent of all pottery products in 1907 and 13.34 in 1906.

The wares embraced under the heading C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware are the most important pottery products from a monetary standard produced in this country, their value being $13,913,680 in 1907, as compared with $14,152,503 in 1906, a decrease of $238,823, or 1.69 per cent. In 1905 these products were valued at $13,196,614, so that it will be seen that 1907, while showing a small loss as against 1906, exceeded the production of 1905 in value by $717,066, or 5.43 per cent. The wares embraced in this column represent the general household wares and compose the bulk of what is known as "pottery." Ohio was the leading producer, reporting material valued at $9,419,960, or 67.70 per cent of the whole. West Virginia was second with a value of $1,651,732, and New Jersey, which was second in 1906, was third with $1,225,691. Ohio and New Jersey each showed a decrease, Ohio from $9,735,072, or 68.79 per cent of the whole, and New Jersey from

$1,436,246, or 10.15 per cent of the whole. West Virginia, on the other hand, showed an increase from $1,047,770 in 1906 to $1,651,732 in 1907. This increase was partly due to the starting up during the year of the large plant at Newell, W. Va. These wares composed 46.16 per cent of the pottery products in 1907 and 45.01 per cent in 1906; they were reported by 77 producers in 1906 and by 68 in 1907.

China, including bone china, delft, and belleek ware, probably the most interesting of all pottery products, showed a slight increase in value from $1,787,776 in 1906 to $1,930,669 in 1907, a gain of $142,893, or 7.99 per cent. As heretofore, these products are reported from but 4 States, for only 2 of which are totals given, owing to the small number of producers. New Jersey is the leading china-producing State, reporting products valued at $1,135,885 in 1907, as compared with $1,065,986 in 1906. New York also showed an increase in these products. These two States produce practically all of the china made in this country, the other two States reporting these wares to the value of only $48,150, or 2.49 per cent of the total. Two more producers reported these wares for 1907 than for 1906, 14 in 1906 and 16 in 1907.

Sanitary ware being used almost exclusively in construction work, showed a decline in sympathy with the decrease in building operations. The decrease in value of this ware in 1907, however, was small, being $235,088, or 4.61 per cent; the value for 1907 was $4,863,222, against $5,098,310 for 1906 and $4,580,145 for 1905. In 1907 the output was from 7 States, New Jersey being by far the largest producer and reporting 74.35 per cent of the total. Indiana was second and West Virginia third in production, with decreases in both States. This ware constituted 16.21 per cent of the pottery products in 1906 and 16.13 per cent in 1907.

The products of the porcelain electrical supply branch of the pottery industry being, like those of sanitary ware, used in construction work, fell off in value in 1907 as compared with 1906 to the extent of $224,513, or 7.91 per cent. The value of the product in 1907 was greater, however, than that for 1905, a year of great prosperity. In 1906 this product was 9.03 per cent of the pottery products and in 1907 it was 8.67 per cent.

Ohio was the leading pottery-producing State, with wares valued at $13,533,199, or 44.90 per cent of the total. This is a decrease of $457,160, or 3.27 per cent, from 1906, when the wares were valued at $13,990,359, or 44.50 per cent of the total. In 1905 the value was $13,024,071, or 46.65 per cent of the total. New Jersey was second in rank, with wares valued at $6,985,626, or 23.18 per cent of the total; in 1906 the value was $7,282,658, or 23.16 per cent of the total. West Virginia, passing both New York and Pennsylvania, was fifth in 1906 and third in 1907, and reported wares valued at $2,159,132, or 7.16 per cent of the total in 1907, and at $1,588,555, or 5.05 per cent of the total, in 1906—an increase in 1907 of $570,577, or 35.92 per cent. New York was fourth in both 1906 and 1907, the value of the product in 1907 being $1,934,498, a gain of $66,151, or 3.54 per cent. Pennsylvania, which was third in 1906, with wares valued at $2,410,817, was fifth in 1907, with wares valued at $1,309,878, a loss of $1,100,939, or 45.67 per cent.

The only other changes in relative rank worthy of note were Georgia, which rose from twenty-second to eighteenth; Iowa, which fell from sixteenth to twenty-second, and Mississippi, which rose from twenty-fourth to twenty-first.

The number of firms reporting pottery sales fell from 540 in 1906 to 509 in 1907. Ohio had the largest number of firms, reporting 118 in 1907 and 126 in 1906. New Jersey reported 57 firms in 1906 and 55 in 1907; Pennsylvania, 46 in 1906 and 40 in 1907; New York, 24 in 1907 and 25 in 1906; West Virginia, 13 in 1906 and 12 in 1907. Illinois reported 23 in 1906 and 24 in 1907, and Indiana reported the same, 18, for both years.

The value of the white ware, exclusive of sanitary ware and porcelain electrical supplies, was $15,844,349 in 1907, against $15,940,279 in 1906, a loss of $95,930, or only 0.6 of 1 per cent. This total for white ware in 1907 is greater by $1,089,005, or 7.38 per cent, than the total for 1905. These products composed 52.56 per cent of the pottery products in 1907 and 50.70 per cent in 1906; if sanitary ware and porcelain electrical supplies be added, most of which are made of high-grade body, the total value of these products in 1907 would be $23,321,342, or 77.37 per cent of all pottery products.

### TRENTON, N. J., AND EAST LIVERPOOL, OHIO.

Although pottery products were reported from 37 States, in only 9 were high-grade general wares made, namely, Illinois, Indiana, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. Of these, two—New Jersey and Ohio—are the leading pottery-producing States, with a combined output in 1907 of 68.08 per cent of the pottery products of the entire country. In New Jersey 93.32 per cent of the total of the State was produced in Trenton; in Ohio the great pottery center is East Liverpool, but its proportion of the State's total in 1907 was much less than that of Trenton, being 42.33 per cent. In 1906 these cities produced, respectively, 93.25 and 43.98 per cent of the State totals. As these two cities may be considered the two leading pottery centers of the country, the following table has been prepared showing the details of production in them:

*Value of pottery products of Trenton, N. J., and East Liverpool, Ohio, in 1906 and 1907, by varieties.*

| Variety. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Trenton. | East Liverpool. | Total. | Trenton. | East Liverpool. | Total. |
| Stoneware and yellow and Rockingham ware | ............ | $72,492 | $72,492 | ............ | $73,444 | $73,444 |
| White ware, C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware | $1,436,246 | 5,317,016 | 6,753,262 | $1,225,691 | 5,030,996 | 6,256,687 |
| China, bone china, delft and belleek ware | 1,065,986 | ............ | 1,065,986 | 1,135,885 | ............ | 1,135,885 |
| Sanitary ware | 3,372,054 | ............ | 3,372,054 | 3,265,625 | ............ | 3,265,625 |
| Porcelain electrical supplies | 778,549 | 604,906 | 1,383,455 | 744,068 | 458,940 | 1,203,008 |
| Miscellaneous[a] | 138,593 | 158,303 | 296,896 | 147,920 | 164,594 | 312,514 |
| Total | 6,791,428 | 6,152,717 | 12,944,145 | 6,519,189 | 5,727,974 | 12,247,163 |
| Per cent of total pottery product | 21.60 | 19.57 | 41.17 | 21.63 | 19.00 | 40.63 |

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[a] Including art and chemical pottery, stilts, pins, and spurs for potters' use; porcelain hardware trimmings; porcelain door and shutter knobs, stems and rings, etc

This table shows that these two cities continue close together in value of products, though the difference in Trenton's favor seems to be growing. In 1906 Trenton's products were valued at $638,711 or 10.38 per cent more than East Liverpool's, and in 1907 at $791,215 or 13.81 per cent more. In 1905 the difference in Trenton's favor was $183,232. Trenton produces no yellow nor Rockingham ware and East Liverpool no china nor sanitary ware. The only important increase noted in this table is in the china from Trenton which increased $69,899 or 6.56 per cent.

These two cities together produced 40.63 per cent of the value of pottery for the whole country in 1907, Trenton reporting 21.63 per cent and East Liverpool 19 per cent. In 1905 the percentages were, Trenton, 22.10; East Liverpool, 21.44; total, 43.54.

## CONSUMPTION.

The pottery imports into the United States in 1907 were valued at $13,585,612 and the production at $30,143,474, a total of $43,729,086. After deducting the exports, domestic $1,131,641 and foreign $36,538 there appears to have been a net consumption of $42,560,907, of which the domestic production was 70.82 per cent. In 1906 the domestic production was 72.26 per cent of the consumption and in 1905 it was 71.81 per cent. The highest proportion reached was 72.91 per cent in 1902.

## IMPORTS AND EXPORTS.

The following table shows the value of imports of clay products from 1903 to 1907, inclusive. It will be noted that the total value has increased every year. The total for 1907 was $13,810,932, as compared with $13,406,899 in 1906, an increase of $404,033, or 3.01 per cent. The increase in 1906 over 1905 was $1,258,758, or 10.36 per cent.

*Value of earthenware, china, brick, and tile imported and entered for consumption in the United States, 1903–1907.*

| Year. | Pottery. | | | | Brick, fire brick, tile, etc. | Grand total. |
|---|---|---|---|---|---|---|
| | Brown earthen and common stone ware.[a] | China and porcelain, not decorated. | China and porcelain, decorated. | Total. | | |
| 1903 | $95,890 | $1,234,223 | $9,897,588 | $11,227,701 | $228,589 | $11,456,290 |
| 1904 | 81,951 | 1,329,146 | 9,859,144 | 11,270,241 | 218,170 | 11,488,411 |
| 1905 | 100,618 | 1,157,573 | 10,717,871 | 11,976,062 | 172,079 | 12,148,141 |
| 1906 | 96,400 | 1,312,326 | 11,822,376 | 13,231,102 | 175,797 | 13,406,899 |
| 1907 | 113,477 | 1,315,591 | 12,156,544 | 13,585,612 | 225,320 | 13,810,932 |

[a] Including Rockingham ware.

It will be noted that practically all of the imports are pottery. In 1907 pottery was 98.37 per cent and brick and tile 1.63 per cent of the total; in 1906 these percentages were respectively, 98.69 and 1.31. Of the pottery imports 99.16 per cent was general ware and 0.84 of 1 per cent of the lower grade wares; in 1906 these percentages were, respectively, 99.27 and 0.73 of 1 per cent. The total pottery imports increased in 1907, $354,510, or 2.68 per cent, over those of 1906. In 1906 the increase was $1,255,040, or 10.48 per cent.

The following table shows the exports of clay products of domestic manufacture from the United States from 1903 to 1907, inclusive.

*Exports of clay wares of domestic manufacture from the United States, 1903-1907.*

| Year. | Brick. | | | | Pottery. | | | Grand total (value) |
|---|---|---|---|---|---|---|---|---|
| | Building. | | Fire (value). | Total (value). | Earthen and stone ware (value). | China (value). | Total (value). | |
| | Quantity (thousands). | Value. | | | | | | |
| 1903 | 8,783 | $63,774 | $375,503 | $439,277 | $527,689 | $61,312 | $589,001 | $1,028,278 |
| 1904 | 25,012 | 179,866 | 407,519 | 587,385 | 697,381 | 94,358 | 791,739 | 1,379,124 |
| 1905 | 34,242 | 263,876 | 536,002 | 799,878 | 882,069 | 101,485 | 983,554 | 1,783,432 |
| 1906 | 27,758 | 247,625 | 637,441 | 885,066 | 1,003,969 | 114,481 | 1,118,450 | 2,003,516 |
| 1907 | 22,340 | 185,192 | 631,779 | 816,971 | 1,022,730 | 108,911 | 1,131,641 | 1,948,612 |

From this table it will be seen that the value of the exports of clay products decreased from $2,003,516 in 1906 to $1,948,612 in 1907—a loss of $54,904, or 2.74 per cent. In 1906 the increase over 1905 was $220,084, or 12.34 per cent.

The pottery exports showed a slight increase from $1,118,450 in 1896 to $1,131,641, a gain of $13,191, or 1.18 per cent, while the brick and tile exports decreased from $885,066 to $816,971, a loss of $68,095, or 7.69 per cent. The decrease in the brick and tile products was almost entirely in the building brick exported, and the increase in the pottery was in the coarser products, the china exported showing a slight decline in value. The average value per thousand of the brick exported was $8.29 in 1907 as compared with $8.92 in 1906 and with $7.71 in 1905.

## CLAY PRODUCTS IN VARIOUS STATES.

The following table gives the statistics of clay products from 1903 to 1907, inclusive, for the more important clay-working States, and will be of interest to those who desire to compare the growth of the industries in these States for several years. Owing to the changes in the classification of the products in some of the minor items, the figures do not always represent solely the values of the products named, though the classification as given in the tables is the nearest that can be made without reconstructing them entirely. The item "Miscellaneous" under each State includes all products not otherwise classified, and those which could not be published separately without disclosing individual returns.

*Clay products of the United States, by States, from 1903 to 1907.*

### CALIFORNIA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 217,715,000 | 256,898,000 | 284,205,000 | 278,780,000 | 339,439,000 |
| Value | $1,600,882 | $1,843,936 | $1,961,909 | $1,962,866 | $2,483,062 |
| Average per M | $7.35 | $7.18 | $6.90 | $7.05 | $7.32 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | (a) | (a) |
| Value | (a) | (a) | (a) | (a) | (a) |
| Average per M | $15.00 | $18.08 | $19.23 | $18.49 | $15.79 |
| Front— | | | | | |
| Quantity | 8,886,000 | 11,722,000 | 11,871,000 | 18,421,000 | 12,922,000 |
| Value | $229,537 | $291,813 | $302,872 | $501,746 | $283,375 |
| Average per M | $25.83 | $24.89 | $25.51 | $27.24 | $21.93 |
| Fancy or ornamental. value | (a) | $27,037 | $31,899 | (a) | $150,165 |
| Fire. do | $200,332 | $285,718 | $290,878 | $347,806 | $374,378 |
| Stove lining. do | (b) | (a) | (a) | (a) | (a) |
| Draintile. do | $17,994 | $29,440 | $27,852 | $30,545 | $53,997 |
| Sewer pipe. do | $411,380 | $568,626 | $663,044 | $827,477 | $1,086,916 |
| Architectural terra cotta. do | $180,488 | $221,000 | $215,160 | $254,932 | $528,623 |
| Fireproofing. do | $61,649 | $51,125 | $45,551 | $98,968 | $149,959 |
| Tile, not drain. do | (a) | (a) | $34,679 | $69,023 | $107,492 |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $37,740 | $45,005 | $53,359 | $62,980 | $82,238 |
| Sanitary ware. value | (a) | .......... | (a) | (a) | (a) |
| Miscellaneous. do | $91,541 | $261,034 | $237,944 | $207,887 | $440,332 |
| Total value | $2,831,543 | $3,624,734 | $3,865,147 | $4,364,230 | $5,740,537 |
| Number of operating firms reporting | 105 | 121 | 122 | 113 | 118 |
| Rank of State | 9 | 8 | 8 | 8 | 8 |

### CONNECTICUT AND RHODE ISLAND.

| | | | | | |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 158,382,000 | 186,908,000 | 211,613,000 | 212,648,000 | 198,414,000 |
| Value | $890,989 | $1,039,204 | $1,329,220 | $1,503,929 | $1,240,575 |
| Average per M | $5.62 | $5.56 | $6.28 | $7.07 | $6.25 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | (a) | (a) |
| Value | (a) | (a) | (a) | (a) | (a) |
| Average per M | $14.03 | $14.00 | $19.00 | $16.36 | $24.23 |
| Front— | | | | | |
| Quantity | (a) | 3,060,000 | (a) | (a) | (a) |
| Value | (a) | $45,730 | (a) | (a) | (a) |
| Average per M | $15.04 | $14.94 | $14.01 | $16.51 | $15.44 |
| Fancy or ornamental. value | (a) | (a) | (a) | .......... | .......... |
| Fire. do | $61,500 | $43,500 | (a) | (a) | (a) |
| Stove lining. do | (b) | (a) | (a) | (a) | (a) |
| Fireproofing. do | (a) | .......... | .......... | .......... | .......... |
| Tile, not drain. do | .......... | (a) | .......... | .......... | .......... |
| Pottery:[c] | | | | | |
| Earthenware and stoneware, value | $42,250 | (a) | (a) | (a) | (a) |
| Miscellaneous. value | $211,330 | $87,175 | $279,358 | $243,276 | $244,017 |
| Total value | $1,206,069 | $1,215,609 | $1,608,578 | $1,747,205 | $1,484,592 |
| Number of operating firms reporting | 41 | 43 | 42 | 42 | 43 |
| Rank of Connecticut and Rhode Island | 23 | 23 | 20 | 20 | 24 |

[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.
[c] Produced by Connecticut alone.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

GEORGIA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 257,844,000 | 269,815,000 | 275,841,000 | 303,286,000 | 318,844,000 |
| Value | $1,305,896 | $1,374,318 | $1,444,479 | $1,783,988 | $1,807,148 |
| Average per M | $5.06 | $5.09 | $5.24 | $5.88 | $5.67 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | (a) | (a) |
| Value | (a) | (a) | (a) | (a) | (a) |
| Average per M | $10.93 | $12.00 | $14.00 | $13.99 | $12.50 |
| Front— | | | | | |
| Quantity | 2,915,000 | 3,924,000 | 2,667,000 | 2,094,000 | 1,625,000 |
| Value | $25,748 | $42,064 | $28,676 | $20,747 | $16,450 |
| Average per M | $8.83 | $10.72 | $10.75 | $9.91 | $10.12 |
| Fancy or ornamental. value | $2,100 | (a) | | | (a) |
| Fire do | $73,600 | $28,100 | $73,050 | $51,310 | $82,391 |
| Stove lining do | (b) | (a) | | | (a) |
| Draintile do | (a) | $8,099 | $13,500 | $12,000 | $8,050 |
| Sewer pipe do | $162,068 | $165,068 | $218,000 | $221,000 | $244,000 |
| Architectural terra cotta do | $85,500 | (a) | (a) | (a) | (a) |
| Fireproofing do | (a) | (a) | (a) | (a) | (a) |
| Tile, not drain do | | (a) | (a) | (a) | (a) |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $21,942 | $22,057 | $21,890 | $20,257 | $33,885 |
| Yellow and Rockingham ware value | | | | | |
| Miscellaneous do | $54,168 | $281,230 | $320,151 | $291,322 | $298,313 |
| Total value | $1,731,022 | $1,920,936 | $2,119,746 | $2,400,624 | $2,490,237 |
| Number of operating firms reporting | 99 | 103 | 95 | 99 | 106 |
| Rank of State | 15 | 12 | 12 | 13 | 13 |

ILLINOIS.

| | | | | | |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 1,015,541,000 | 999,310,000 | 1,125,024,000 | 1,195,210,000 | 1,494,807,000 |
| Value | $5,388,589 | $5,167,165 | $6,259,232 | $5,719,906 | $6,499,777 |
| Average per M | $5.31 | $5.17 | $5.56 | $4.79 | $4.35 |
| Vitrified— | | | | | |
| Quantity | 96,568,000 | 121,073,000 | 90,563,000 | 122,227,000 | 126,927,000 |
| Value | $1,015,710 | $1,234,703 | $973,247 | $1,306,476 | $1,405,821 |
| Average per M | $10.52 | $10.20 | $10.75 | $10.69 | $11.08 |
| Front— | | | | | |
| Quantity | 25,122,000 | 21,299,000 | 30,447,000 | 30,022,000 | 20,828,000 |
| Value | $274,723 | $251,762 | $348,354 | $341,298 | $266,270 |
| Average per M | $10.93 | $11.82 | $11.44 | $11.37 | $12.78 |
| Fancy or ornamental. value | $12,927 | $11,733 | $13.567 | $11,635 | (a) |
| Fire do | $233,106 | $217,008 | $176,692 | $236,032 | $241,008 |
| Draintile do | $892,807 | $1,002,463 | $1,051,852 | $1,052,588 | $1,031,192 |
| Sewer pipe do | $532,858 | $550,344 | $580,538 | $587,805 | $662,487 |
| Architectural terra cotta do | $1,198,477 | (a) | (a) | (a) | (a) |
| Fireproofing do | $335,838 | $324,264 | $323,550 | $409,171 | $404,265 |
| Tile, not drain do | $283,426 | $194,471 | (a) | (a) | (a) |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $694,770 | $801,946 | $889,857 | $935,193 | $935,312 |
| Yellow and Rockingham ware value | (a) | (a) | (a) | | |
| C. C. and white granite ware, value | $168,363 | | | (a) | (a) |
| Semivitreous porcelain ware, value | (c) | | | | |
| Miscellaneous value | $159,203 | $1,021,588 | $1,744,897 | $2,034,077 | $1,774,357 |
| Total value | $11,190,797 | $10,777,447 | $12,361,786 | $12,634,181 | $13,220,489 |
| Number of operating firms reporting | 502 | 492 | 469 | 466 | 417 |
| Rank of State | 4 | 4 | 5 | 5 | 4 |

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[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.
[c] Included in C. C. and white granite ware.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

### INDIANA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 294,890,000 | 283,707,000 | 279,073,000 | 307,076,000 | 251,766,000 |
| Value | $1,697,190 | $1,677,714 | $1,630,072 | $1,778,270 | $1,509,415 |
| Average per M | $5.76 | $5.91 | $5.84 | $5.79 | $6.00 |
| Vitrified— | | | | | |
| Quantity | 47,864,000 | 51,859,000 | 43,573,000 | 45,725,000 | 46,224,000 |
| Value | $482,967 | $513,209 | $474,600 | $502,509 | $548,448 |
| Average per M | $10.09 | $9.90 | $10.89 | $10.99 | $11.87 |
| Front— | | | | | |
| Quantity | 24,742,000 | 19,890,000 | 22,212,000 | 35,090,000 | 36,890,000 |
| Value | $232,487 | $197,890 | $231,353 | $395,368 | $437,796 |
| Average per M | $9.36 | $9.95 | $10.42 | $11.27 | $11.87 |
| Fancy or ornamental . value | (a) | (a) | $15,520 | $4,700 | (a) |
| Fire . do | $115,526 | $130,216 | $163,728 | $149,351 | $160,373 |
| Stove lining . do | (b) | (a) | (a) | (a) | ........ |
| Draintile . do | $1,014,706 | $1,205,717 | $1,267,691 | $1,373,441 | $1,437,735 |
| Sewer pipe . do | $363,212 | $294,000 | $430,680 | $486,897 | $487,537 |
| Architectural terra cotta . do | (a) | (a) | (a) | (a) | (a) |
| Fireproofing . do | (a) | $210,800 | $393,985 | $323,015 | $304,151 |
| Tile, not drain . do | $463,082 | (a) | (a) | (a) | (a) |
| Pottery: | | | | | |
| Earthenware and stoneware . value | $73,160 | $65,390 | $74,462 | $73,324 | $50,654 |
| C. C. ware, white granite, semiporcelain and semivitreous porcelain ware, value | (a) | (a) | (a) | (a) | (a) |
| Sanitary ware . value | (a) | $425,000 | $496,000 | $435,000 | $400,000 |
| Miscellaneous . do | $1,252,295 | $1,182,653 | $1,321,482 | $1,636,359 | $1,522,015 |
| Total value | $5,694,625 | $5,902,589 | $6,499,573 | $7,158,234 | $6,858,124 |
| Number of operating firms reporting | 490 | 465 | 441 | 419 | 392 |
| Rank of State | 6 | 6 | 6 | 6 | 7 |

### IOWA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 191,323,000 | 207,041,000 | 193,250,000 | 168,871,000 | 157,618,000 |
| Value | $1,355,129 | $1,440,758 | $1,366,653 | $1,118,709 | $1,085,383 |
| Average per M | $7.08 | $6.96 | $7.07 | $6.62 | $6.89 |
| Vitrified— | | | | | |
| Quantity | 21,888,000 | 19,231,000 | 13,253,000 | 16,930,000 | 21,686,000 |
| Value | $232,510 | $199,528 | $134,802 | $185,990 | $223,193 |
| Average per M | $10.62 | $10.38 | $10.17 | $10.99 | $10.29 |
| Front— | | | | | |
| Quantity | 12,815,000 | 7,994,000 | 5,676,000 | 8,871,000 | 8,028,000 |
| Value | $135,849 | $91,269 | $60,669 | $101,795 | $96,316 |
| Average per M | $10.60 | $11.42 | $10.69 | $11.48 | $12.00 |
| Fancy or ornamental . value | (a) | (a) | ........ | ........ | ........ |
| Fire . do | $975 | (a) | $869 | $930 | $795 |
| Stove lining . do | (b) | (a) | ........ | ........ | ........ |
| Draintile . do | $1,028,383 | $1,294,134 | $1,509,226 | $1,721,614 | $2,011,793 |
| Sewer pipe . do | (a) | (a) | (a) | (a) | (a) |
| Fireproofing, terra-cotta lumber, and hollow building block or tile . value | $131,191 | $161,658 | $137,554 | $162,664 | $176,854 |
| Tile, not drain . do | (a) | $4,300 | (a) | ........ | ........ |
| Pottery: | | | | | |
| Earthenware and stoneware . value | $52,922 | $66,050 | $68,859 | $54,600 | $15,382 |
| Miscellaneous . do | $156,444 | $203,156 | $113,490 | $122,725 | $119,069 |
| Total value | $3,093,403 | $3,460,853 | $3,392,122 | $3,469,027 | $3,728,785 |
| Number of operating firms reporting | 304 | 327 | 306 | 304 | 276 |
| Rank of State | 8 | 9 | 9 | 9 | 9 |

[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

## KENTUCKY.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 123,309,000 | 138,677,000 | 147,702,000 | 142,185,000 | 143,731,000 |
| Value | $689,403 | $796,074 | $862,330 | $881,879 | $932,469 |
| Average per M | $5.59 | $5.74 | $5.84 | $6.20 | $6.49 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | (a) | (a) |
| Value | (a) | (a) | (a) | (a) | (a) |
| Average per M | $15.20 | $14.91 | $14.27 | $14.13 | $14.27 |
| Front— | | | | | |
| Quantity | 6,869,000 | 2,178,000 | 11,558,000 | 11,893,000 | 7,926,000 |
| Value | $53,769 | $20,571 | $128,777 | $109,771 | $86,568 |
| Average per M | $7.83 | $9.44 | $11.14 | $9.23 | $10.92 |
| Fire ...... value | $873,294 | $680,084 | $739,059 | $898,527 | $940,415 |
| Stove lining ...... do | (b) | (a) | | | |
| Draintile ...... do | $20,621 | $26,564 | $28,865 | $27,359 | $32,723 |
| Sewer pipe ...... do | (a) | (a) | (a) | (a) | (a) |
| Architectural terra cotta ...... do | | | (a) | | |
| Fireproofing ...... do | (a) | (a) | | | |
| Tile, not drain ...... do | $222,420 | (a) | $296,949 | $296,391 | $255,054 |
| Pottery: | | | | | |
| Earthenware and stoneware ...... value | $139,827 | $157,613 | $157,083 | $167,209 | $166,621 |
| Miscellaneous ...... do | $191,625 | $406,371 | $193,287 | $211,287 | $197,514 |
| Total value | $2,190,959 | $2,087,277 | $2,406,350 | $2,592,423 | $2,611,364 |
| Number of operating firms reporting | 113 | 120 | 121 | 117 | 115 |
| Rank of State | 11 | 10 | 10 | 11 | 11 |

## MARYLAND.

| | | | | | |
|---|---|---|---|---|---|
| **Brick:** | | | | | |
| **Common—** | | | | | |
| **Quantity** | **147,663,000** | **160,279,000** | **210,446,000** | **204,238,000** | **166,768,000** |
| **Value** | **$976,969** | **$1,048,850** | **$1,423,663** | **$1,267,771** | **$1,026,922** |
| **Average per M** | **$6.62** | **$6.54** | **$6.76** | **$6.21** | **$6.16** |
| **Vitrified—** | | | | | |
| **Quantity** | (a) | (a) | (a) | (a) | (a) |
| **Value** | (a) | (a) | (a) | (a) | (a) |
| **Average per M** | **$9.46** | **$10.08** | **$17.96** | **$15.60** | **$15.00** |
| **Front—** | | | | | |
| **Quantity** | **2,728,000** | **2,245,000** | **1,426,000** | **2,266,000** | **1,597,000** |
| **Value** | **$40,479** | **$37,537** | **$24,118** | **$31,968** | **$19,854** |
| **Average per M** | **$14.84** | **$16.72** | **$16.91** | **$14.11** | **$12.43** |
| **Fancy or ornamental ...... value** | (a) | (a) | (a) | (a) | (a) |
| **Fire ...... do** | **$272,295** | **$235,136** | **$224,667** | **$266,980** | **$242,312** |
| **Stove lining ...... do** | (b) | (a) | **$32,890** | **$32,200** | **$31,048** |
| **Draintile ...... do** | **$1,355** | **$2,848** | **$4,703** | **$3,315** | **$3,190** |
| **Architectural terra cotta ...... do** | (a) | (a) | (a) | (a) | (a) |
| **Tile, not drain ...... do** | (a) | (a) | (a) | (a) | (a) |
| **Pottery:** | | | | | |
| **Earthenware and stoneware ...... value** | **$16,428** | **$13,440** | **$13,325** | **$17,499** | (a) |
| **Yellow and Rockingham ware ...... value** | (a) | (a) | (a) | | |
| **C. C. and white granite semiporcelain and semivitreous porcelain ware, value** | **$450,000** | **$382,500** | (a) | **$352,000** | **$348,890** |
| **Miscellaneous ...... value** | **$151,295** | **$151,746** | **$526,001** | **$164,806** | **$214,416** |
| **Total value** | **$1,908,821** | **$1,872,057** | **$2,249,367** | **$2,136,539** | **$1,886,362** |
| **Number of operating firms reporting** | **59** | **63** | **68** | **70** | **63** |
| **Rank of State** | **14** | **13** | **11** | **15** | **18** |

[a] Included in miscellaneous.

[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

### MASSACHUSETTS.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| **Brick:** | | | | | |
| Common— | | | | | |
| Quantity | 190,812,000 | 165,435,000 | 194,504,000 | 204,282,000 | 184,005,000 |
| Value | $1,236,103 | $1,012,226 | $1,264,787 | $1,415,864 | $1,294,918 |
| Average per M | $6.48 | $6.12 | $6.50 | $6.93 | $7.04 |
| Vitrified— | | | | | |
| Quantity | ........ | (a) | ........ | ........ | ........ |
| Value | ........ | (a) | ........ | ........ | ........ |
| Average per M | ........ | $14.00 | ........ | ........ | ........ |
| Front— | | | | | |
| Quantity | 2,625,000 | (a) | 2,080,000 | (a) | (a) |
| Value | $52,450 | (a) | $33,971 | (a) | (a) |
| Average per M | $19.98 | $21.67 | $16.33 | $22.17 | $37.13 |
| Fancy or ornamental . value | (a) | (a) | (a) | (a) | (a) |
| Fire . do | $200,225 | (a) | $68,180 | $57,940 | $74,115 |
| Stove lining . do | (b) | (a) | $173,151 | $186,815 | $206,042 |
| Architectural terracotta . do | (a) | (a) | (a) | (a) | (a) |
| Fireproofing . do | (a) | (a) | (a) | (a) | (a) |
| Tile, not drain . do | (a) | $72,000 | $82,000 | $91,394 | $123,220 |
| **Pottery:** | | | | | |
| Earthenware and stoneware, value | $198,382 | $193,633 | $208,950 | $189,370 | $184,671 |
| C. C. and white granite ware, value | (a) | (a) | (a) | (a) | (a) |
| Miscellaneous . value | $421,525 | $451,199 | $219,418 | $231,350 | $245,854 |
| Total value | $2,108,685 | $1,729,058 | $2,050,457 | $2,172,733 | $2,128,820 |
| Number of operating firms reporting | 86 | 87 | 78 | 82 | 80 |
| Rank of State | 12 | 16 | 13 | 14 | 15 |

### MICHIGAN.

| | | | | | |
|---|---|---|---|---|---|
| **Brick:** | | | | | |
| Common— | | | | | |
| Quantity | 215,791,000 | 205,196,000 | 211,558,000 | 206,583,000 | 200,817,000 |
| Value | $1,251,572 | $1,116,714 | $1,152,505 | $1,178,202 | $1,181,015 |
| Average per M | $5.80 | $5.44 | $5.45 | $5.70 | $5.88 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | 6,112,000 | 6,229,000 | 7,911,000 |
| Value | (a) | (a) | $81,706 | $81,814 | $94,601 |
| Average per M | $13.27 | $13.28 | $13.37 | $13.13 | $11.96 |
| Front— | | | | | |
| Quantity | 2,225,000 | 1,080,000 | 693,000 | 1,474,000 | 3,956,000 |
| Value | $19,000 | $7,500 | $5,995 | $14,162 | $32,116 |
| Average per M | $8.54 | $6.94 | $8.65 | $9.61 | $8.12 |
| Fancy or ornamental . value | (a) | (a) | ........ | (a) | ........ |
| Fire . do | (a) | (a) | (a) | (a) | (a) |
| Stove lining . do | (b) | (a) | (a) | (a) | ........ |
| Draintile . do | $129,028 | $208,088 | $205,445 | $314,098 | $289,868 |
| Sewer pipe . do | (a) | (a) | (a) | (a) | (a) |
| Architectural terra cotta . do | (a) | ........ | ........ | ........ | ........ |
| Fireproofing, terra cotta lumber, and hollow building tile or blocks . value | $19,138 | $8,080 | (a) | $4,290 | $6,386 |
| Tile, not drain . do | ........ | ........ | ........ | ........ | (a) |
| **Pottery:** | | | | | |
| Earthenware and stoneware, value | $42,007 | $40,621 | (a) | $43,510 | $54,474 |
| Miscellaneous . value | $249,676 | $333,510 | $320,056 | $208,401 | $189,304 |
| Total value | $1,710,421 | $1,714,513 | $1,765,707 | $1,844,477 | $1,847,764 |
| Number of operating firms reporting | 178 | 168 | 154 | 142 | 136 |
| Rank of State | 16 | 17 | 17 | 18 | 19 |

[a] Included in miscellaneous.

[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

### MINNESOTA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 161,911,000 | 164,154,000 | 166,233,000 | 165,598,000 | 168,931,000 |
| Value | $982,728 | $970,247 | $977,837 | $986,982 | $1,045,874 |
| Average per M | $6.07 | $5.91 | $5.88 | $5.96 | $6.19 |
| Vitrified— | | | | | |
| Quantity | 195,000 | (a) | (a) | (a) | (a) |
| Value | $1,875 | (a) | (a) | (a) | (a) |
| Average per M | $9.62 | $10.00 | $14.54 | $10.68 | $12.00 |
| Front— | | | | | |
| Quantity | 6,922,000 | 6,566,000 | 6,636,000 | 7,510,000 | (a) |
| Value | $78,930 | $113,260 | $85,300 | $98,170 | (a) |
| Average per M | $11.40 | $17.25 | $12.85 | $13.07 | $12.93 |
| Fancy or ornamental. value | (a) | (a) | ........ | ........ | (a) |
| Fire do | ........ | ........ | (a) | (a) | (a) |
| Draintile do | $10,087 | $11,100 | $15,770 | $41,779 | $49,622 |
| Sewer pipe do | (a) | (a) | (a) | (a) | (a) |
| Fireproofing do | (a) | (a) | (a) | (a) | (a) |
| Pottery: | | | | | |
| Earthenware and stoneware, value | (b) | (b) | (b) | (b) | (b) |
| Miscellaneous value | $453,388 | $225,300 | $420,479 | $476,348 | $594,437 |
| Total value | $1,527,008 | $1,319,907 | $1,499,386 | $1,603,279 | $1,689,933 |
| Number of operating firms reporting | 116 | 114 | 111 | 109 | 106 |
| Rank of State | 18 | 21 | 21 | 23 | 21 |

### MISSOURI.

| | | | | | |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 274,755,000 | 271,370,000 | 316,002,000 | 257,292,000 | 264,462,000 |
| Value | $1,725,253 | $1,690,460 | $2,028,957 | $1,810,304 | $1,844,255 |
| Average per M | $6.28 | $6.23 | $6.42 | $7.04 | $6.97 |
| Vitrified— | | | | | |
| Quantity | 31,496,000 | 47,235,000 | 43,375,000 | 57,414,000 | 47,807,000 |
| Value | $307,237 | $480,671 | $470,935 | $539,700 | $462,341 |
| Average per M | $9.75 | $10,17 | $10.86 | $9.40 | $9.67 |
| Front— | | | | | |
| Quantity | 26,153,000 | 25,599,000 | 28,224,000 | 29,019,000 | 30,178,000 |
| Value | $333,965 | $322,445 | $362,996 | $394,563 | $387,455 |
| Average per M | $12.77 | $12.60 | $12.86 | $13.59 | $12.84 |
| Fancy or ornamental. value | $39,756 | $32,967 | $44,632 | $30,689 | $33,638 |
| Fire do | $925,915 | $925,520 | $1,117,209 | $1,324,895 | $1,634,209 |
| Stove lining do | (c) | (a) | (a) | (a) | (a) |
| Draintile do | $45,363 | $80,479 | $59,858 | $64,063 | $72,316 |
| Sewer pipe do | $1,050,794 | $1,176,679 | $1,101,938 | $1,208,236 | $1,332,080 |
| Architectural terra cotta do | $371,006 | (a) | (a) | (a) | (a) |
| Fireproofing, terra cotta lumber, and hollow building tile or blocks value | $98,888 | (a) | (a) | (a) | (a) |
| Tile, not drain do | $235,091 | (a) | (a) | (a) | (a) |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $50,001 | $69,327 | $43,368 | $69,500 | $72,612 |
| Miscellaneous value | $478,338 | $702,956 | $973,518 | $1,254,325 | $1,059,965 |
| Total value | $5,661,607 | $5,481,504 | $6,203,411 | $6,696,275 | $6,898,871 |
| Number of operating firms reporting | 242 | 232 | 224 | 190 | 172 |
| Rank of State | 7 | 7 | 7 | 7 | 6 |

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[a] Included in miscellaneous.

[b] The value of pottery products for Minnesota could not be included in the State totals without disclosing the operations of individual establishments.

[c] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

NEW JERSEY.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 272,178,000 | 319,975,000 | 465,040,000 | 413,258,000 | 388,735,000 |
| Value | $1,500,295 | $1,842,075 | $3,090,809 | $2,610,686 | $2,289,883 |
| Average per M | $5.51 | $5.76 | $6.65 | $6.32 | $5.89 |
| Vitrified— | | | | | |
| Quantity | 1,402,000 | 4,953,000 | 991,000 | (a) | (a) |
| Value | $22,195 | $66,813 | $13,803 | (a) | (a) |
| Average per M | $15.83 | $13.49 | $13.93 | $14.98 | $13.31 |
| Front— | | | | | |
| Quantity | 41,075,000 | 47,058,000 | 53,770,000 | 62,138,000 | 61,521,000 |
| Value | $548,553 | $687,469 | $852,744 | $896,887 | $825,767 |
| Average per M | $13.35 | $14.61 | $15.86 | $14.43 | $13.42 |
| Fancy or ornamental . value | $14,970 | (a) | $1,975 | $1,951 | $4,605 |
| Enameled . do | (a) | (a) | (a) | (a) | (a) |
| Fire . do | $949,392 | $906,882 | $1,393,448 | $954,081 | $947,472 |
| Stove lining . do | (b) | (a) | (a) | (a) | (a) |
| Draintile . do | $20,825 | $24,842 | $24,315 | $23,209 | $21,869 |
| Sewer pipe . do | (a) | $23,299 | $56,576 | (a) | (a) |
| Architectural terra cotta . do | $1,364,094 | $1,412,023 | $1,614,263 | $1,682,022 | $1,722,567 |
| Fireproofing, terra-cotta lumber, and hollow building tile or blocks . value | $1,325,654 | $1,211,646 | $1,308,075 | $1,485,195 | $1,159,467 |
| Tile, not drain . do | $734,159 | $548,097 | $585,130 | $1,163,401 | $1,050,085 |
| Pottery: | | | | | |
| Earthenware and stoneware . value | $65,004 | $70,819 | $70,825 | $76,793 | $77,488 |
| Yellow and Rockingham ware . value | (a) | | | | |
| C. C. ware . do | $454,029 | $325,959 | (a) | $1,436,246 | $1,225,691 |
| White granite ware . do | $1,575,892 | $1,284,199 | $1,288,926 | | |
| Semivitreous porcelain ware . value | | | | | |
| China . do | $805,691 | $816,374 | $816,917 | $1,065,986 | $1,135,885 |
| Bone china, delft, and belleek ware . value | $106,000 | $162,500 | $129,000 | | |
| Sanitary ware . do | $2,794,984 | $2,878,621 | $3,426,291 | $3,742,045 | $3,615,685 |
| Porcelain electrical supplies . value | $385,398 | $302,293 | $540,206 | $783,549 | $744,068 |
| Miscellaneous . do | $749,804 | $738,136 | $1,486,222 | $1,440,218 | $1,185,428 |
| Total value | $13,416,939 | $13,304,047 | $16,609,525 | $17,362,269 | $16,005,460 |
| Number of operating firms reporting | 159 | 161 | 163 | 175 | 165 |
| Rank of State | 3 | 3 | 3 | 3 | 3 |

[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

NEW YORK.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 1,068,464,000 | 1,169,233,000 | 1,518,196,000 | 1,535,579,000 | 1,319,416,000 |
| Value | $5,305,522 | $6,783,528 | $10,297,214 | $9,205,981 | $7,056,453 |
| Average per M | $4.96 | $5.80 | $6.78 | $6.00 | $5.35 |
| Vitrified— | | | | | |
| Quantity | 16,797,000 | 14,490,000 | 12,076,000 | 10,787,000 | 18,516,000 |
| Value | $220,296 | $189,281 | $149,391 | $163,969 | $253,664 |
| Average per M | $13.11 | $13.06 | $12.37 | $15.20 | $13.70 |
| Front— | | | | | |
| Quantity | 18,383,000 | 19,104,000 | 12,610,000 | 23,625,000 | 12,265,000 |
| Value | $248,760 | $263,150 | $237,305 | $351,824 | $198,265 |
| Average per M | $13.53 | $13.77 | $18.82 | $14.89 | $16.17 |
| Fancy or ornamental . value | (a) | (a) | (a) | | (a) |
| Enameled . do | | | | (a) | |
| Fire . do | $629,245 | $381,784 | $427,873 | $451,783 | $538,721 |
| Stove lining . do | (b) | (a) | $133,383 | $131,908 | $129,467 |
| Draintile . do | $140,181 | $139,876 | $153,598 | $153,237 | $180,818 |
| Sewer pipe . do | $134,360 | $125,510 | (a) | (a) | (a) |
| Architectural terra cotta . do | $947,153 | $785,978 | $874,722 | $967,987 | $1,089,278 |
| Fireproofing . do | (a) | $132,034 | $117,577 | $75,631 | $73,064 |
| Tile, not drain . do | $150,504 | $154,417 | $164,445 | $101,319 | $43,726 |
| Pottery: | | | | | |
| Earthenware and stoneware . value | $82,310 | $74,781 | $83,780 | $104,165 | $120,367 |
| Yellow and Rockingham ware . value | (a) | (a) | | | |
| C. C. and white granite ware . value | (a) | (a) | (a) | (a) | (a) |
| China . do | (a) | (a) | (a) | $657,817 | $746,634 |
| Sanitary ware . do | (a) | (a) | (a) | (a) | (a) |
| Porcelain electrical supplies . value | $474,842 | $438,792 | $617,663 | $663,886 | $626,032 |
| Miscellaneous . do | $875,079 | $1,073,939 | $1,229,396 | $847,100 | $716,385 |
| Total value | $9,208,252 | $10,543,070 | $14,486,347 | $13,876,607 | $11,772,874 |
| Number of operating firms reporting | 242 | 240 | 249 | 253 | 247 |
| Rank of State | 5 | 5 | 4 | 4 | 5 |

[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

OHIO.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 497,071,000 | 455,936,000 | 514,419,000 | 550,422,000 | 495,025,000 |
| Value | $3,002,506 | $2,708,456 | $3,033,435 | $3,243,157 | $3,012,485 |
| Average per M | $6.04 | $5.94 | $5.90 | $5.89 | $6.09 |
| Vitrified— | | | | | |
| Quantity | 202,649,000 | 218,791,000 | 224,086,000 | 202,978,000 | 264,571,000 |
| Value | $1,860,071 | $2,222,931 | $2,055,120 | $1,955,360 | $2,672,600 |
| Average per M | $9.17 | $10.16 | $9.17 | $9.63 | $10.10 |
| Front— | | | | | |
| Quantity | 50,997,000 | 65,645,000 | 89,390,000 | 90,310,000 | 88,992,000 |
| Value | $633,101 | $755,870 | $1,074,007 | $1,025,590 | $1,033,434 |
| Average per M | $12.41 | $11.51 | $12.01 | $11.36 | $11.61 |
| Fancy or ornamental ... value | $42,522 | $64,514 | $18,153 | $38,218 | $24,468 |
| Fire ... do | $1,561,936 | $1,186,966 | $1,427,919 | $1,670,630 | $1,668,728 |
| Stove lining ... do | (a) | (b) | $49,538 | $110,800 | $22,416 |
| Draintile ... do | $1,149,990 | $1,143,957 | $1,291,323 | $1,520,748 | $1,433,341 |
| Sewer pipe ... do | $3,295,635 | $3,495,917 | $3,550,160 | $3,987,360 | $3,792,352 |
| Architectural terra cotta ... do | (b) | .......... | .......... | (b) | (b) |
| Fireproofing, terra-cotta lumber, and hollow building tile or blocks ... value | $865,649 | $788,825 | $923,762 | $1,159,021 | $1,006,076 |
| Tile, not drain ... do | $1,072,103 | $1,005,611 | $1,188,460 | $1,523,410 | $1,586,174 |
| Pottery: | | | | | |
| Earthenware and stoneware ... value | $1,225,735 | $1,226,973 | $1,448,007 | $1,787,990 | $1,790,255 |
| Yellow and Rockingham ware ... value | $222,904 | $231,994 | $177,143 | | |
| C. C. ware ... do | $762,475 | $503,945 | $609,478 | $9,735,072 | $9,419,960 |
| White granite ware ... do | $6,681,080 | $7,422,196 | $8,521,944 | | |
| Semivitreous porcelain ware ... value | | | | | |
| China ... do | $265,300 | $280,614 | (b) | (b) | (b) |
| Sanitary ware ... do | (b) | (b) | (b) | $285,000 | $226,000 |
| Porcelain electrical supplies ... value | $486,740 | $557,027 | $879,207 | $1,100,979 | $933,256 |
| Miscellaneous ... do | $2,080,381 | $2,051,987 | $2,055,383 | $1,870,830 | $1,719,285 |
| Total value | $25,208,128 | $25,647,783 | $28,303,039 | $31,014,165 | $30,340,830 |
| Number of operating firms reporting | 815 | 819 | 792 | 784 | 736 |
| Rank of State | 1 | 1 | 1 | 1 | 1 |

[a] Stove lining included in fire brick in 1903.
[b] Included in miscellaneous.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

PENNSYLVANIA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 927,212,000 | 856,963,000 | 1,036,777,000 | 1,027,541,000 | 980,102,000 |
| Value | $6,174,437 | $5,439,116 | $6,532,814 | $6,586,374 | $6,353,799 |
| Average per M | $6.66 | $6.35 | $6.30 | $6.41 | $6.48 |
| Vitrified— | | | | | |
| Quantity | 72,039 000 | 71,522.000 | 71,888.000 | 93,417,000 | 115,729,000 |
| Value | $685,274 | $766,638 | $750,389 | $996,347 | $1,232,718 |
| Average per M | $9.51 | $10.72 | $10.44 | $10.67 | $10.65 |
| Front— | | | | | |
| Quantity | 80,177 000 | 75,407 000 | 131,368 000 | 151,138,000 | 134,869,000 |
| Value | $1,050,805 | $962,765 | $1,683,031 | $1,761,991 | $1,526,565 |
| Average per M | $13 11 | $12 77 | $12 81 | $11.66 | $11.32 |
| Fancy or ornamental. value | $32,602 | $23,317 | $37,966 | $40,880 | $17,727 |
| Enameled do | (a) | (a) | (a) | (a) | (a) |
| Fire do | $6,537,076 | $5,477,475 | $5,771,795 | $6,854,640 | $6,907,904 |
| Stove lining do | (b) | (a) | $180,353 | $203,674 | $179,218 |
| Draintile do | $11,451 | $8,646 | $13,509 | $9,113 | $10,386 |
| Sewer pipe do | $727,465 | $834,646 | $886,979 | $985,635 | $795,991 |
| Architectural terra cotta do | $329,004 | $349,317 | $405,015 | $367,353 | $507,116 |
| Fireproofing, terra-cotta lumber, hollow building tile or blocks value | $278,621 | $193,190 | $352,107 | $242,668 | $244,773 |
| Tile, not drain do | $207,608 | $215,107 | $310,931 | $389,013 | $406,269 |
| Pottery: | | | | | |
| Earthenware and stoneware value | $533,535 | $504,221 | $459,111 | $477,223 | $544,457 |
| Yellow and Rockingham ware value | (a) | (a) | (a) | | |
| C. C. ware do | .......... | (a) | .......... | $845,366 | $531,634 |
| White granite ware do | $1,036,194 | $707,809 | $716,245 | | |
| Sanitary ware do | $144,414 | (a) | (a) | $186,560 | $192,854 |
| Miscellaneous do | $1,098,838 | $1,339,616 | $1,024,308 | $1,827,774 | $840,210 |
| Total value | $18,847,324 | $16,821,863 | $19,124,553 | $21,774,611 | $20,291,621 |
| Number of operating firms reporting | 523 | 529 | 516 | 514 | 487 |
| Rank of State | 2 | 2 | 2 | 2 | 2 |

TEXAS.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 178,134,000 | 197,033,000 | 202,070,000 | 211,842,000 | 243,853,000 |
| Value | $1,074,051 | $1,157,130 | $1,209,898 | $1,307,199 | $1,707,812 |
| Average per M | $6.03 | $5.87 | $5.99 | $6.17 | $7.00 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | (a) | (a) |
| Value | (a) | (a) | (a) | (a) | (a) |
| Average per M | $9.53 | $8.81 | $10.47 | $10.00 | $10.36 |
| Front— | | | | | |
| Quantity | 5,462,000 | 5,645,000 | 8,001,000 | 8,492,000 | 11,494,000 |
| Value | $65,628 | $58,734 | $102,054 | $110,189 | $153,187 |
| Average per M | $12 02 | $10.40 | $12.76 | $12.98 | $13.33 |
| Fancy or ornamental. value | $11,240 | $2,544 | $18,127 | (a) | .......... |
| Fire do | $22,333 | $30,208 | $14,724 | $45,557 | $75,946 |
| Draintile do | (a) | (a) | .......... | $3,652 | (a) |
| Sewer pipe do | (a) | (a) | (a) | (a) | (a) |
| Tile, not drain do | (a) | (a) | .......... | (a) | .......... |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $96,136 | $106,471 | $100,788 | $108,635 | $156,173 |
| Miscellaneous value | $203,192 | $181,010 | $273,354 | $394,366 | $464,443 |
| Total value | $1,472,580 | $1,536,097 | $1,718,945 | $1,969,598 | $2,557,561 |
| Number of operating firms reporting | 168 | 152 | 129 | 139 | 131 |
| Rank of State | 20 | 18 | 18 | 16 | 12 |

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[a] Included in miscellaneous.
[b] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

### VIRGINIA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 189,891,000 | 203,484,000 | 237,161,000 | 232,697,000 | 197,052,000 |
| Value | $1,245,861 | $1,292,558 | $1,572,442 | $1,536,312 | $1,285,374 |
| Average per M | $6.56 | $6.35 | $6.63 | $6.60 | $6.52 |
| Vitrified— | | | | | |
| Quantity | (a) | (a) | (a) | | |
| Value | (a) | (a) | (a) | | |
| Average per M | $8.92 | $10.46 | $10.80 | | |
| Front— | | | | | |
| Quantity | 18,866,000 | 21,077,000 | 22,155,000 | 25,385,000 | 19,989,000 |
| Value | $303,431 | $344,891 | $352,297 | $392,130 | $290,411 |
| Average per M | $16.08 | $16.36 | $15.90 | $15.45 | $14.53 |
| Fancy or ornamental, value | $27,330 | $28,576 | $20,363 | (a) | (a) |
| Fire, do | (a) | (a) | (a) | $21,110 | (a) |
| Draintile, do | $4,750 | $5,673 | $4,500 | $4,805 | $6,250 |
| Pottery: | | | | | |
| Earthenware and stoneware, value | (a) | (a) | | | |
| Porcelain electrical supplies, value | | (a) | (b) | (b) | (b) |
| Miscellaneous, value | $91,974 | $64,694 | $44,976 | $11,721 | $29,300 |
| Total value | $1,673,346 | $1,736,392 | $1,994,578 | $1,966,078 | $1,611,335 |
| Number of operating firms reporting | 100 | 99 | 94 | 91 | 87 |
| Rank of State | 17 | 15 | 15 | 17 | 23 |

### WEST VIRGINIA.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 88,060,000 | 68,133,000 | 69,228,000 | 74,833,000 | 58,102,000 |
| Value | $576,404 | $469,501 | $476,630 | $469,527 | $384,007 |
| Average per M | $6.55 | $6.89 | $6.88 | $6.27 | $6.61 |
| Vitrified— | | | | | |
| Quantity | 51,762,000 | 39,620,000 | 24,692,000 | 47,902,000 | 60,681,000 |
| Value | $576,258 | $470,330 | $263,449 | $578,164 | $952,060 |
| Average per M | $11.13 | $11.87 | $10.67 | $12.07 | $15.69 |
| Front— | | | | | |
| Quantity | 269,000 | 388,000 | (a) | (a) | (a) |
| Value | $3,356 | $5,380 | (a) | (a) | (a) |
| Average per M | $12.48 | $13.87 | $16.67 | $15.00 | $15.16 |
| Fire, value | $70,802 | $11,814 | $26,868 | $59,757 | $34,438 |
| Stove lining, do | (c) | (a) | | | |
| Draintile, do | $1,499 | $1,398 | (a) | (a) | $1,211 |
| Sewer pipe, do | (a) | (a) | (a) | (a) | |
| Tile, not drain, do | (a) | (a) | (a) | (a) | $52,429 |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $16,600 | $18,923 | $19,110 | $23,200 | (a) |
| C. C. and white granite ware, value<br>Semivitreous porcelain ware, value | $1,099,900 | $912,935 | (a) | $1,047,770 | $1,651,732 |
| Sanitary ware, value | (a) | (a) | (a) | $387,000 | $378,000 |
| Miscellaneous, do | $213,741 | $184,259 | $1,232,738 | $217,894 | $186,510 |
| Total value | $2,558,560 | $2,074,549 | $2,018,795 | $2,783,312 | $3,640,387 |
| Number of operating firms reporting | 56 | 64 | 62 | 65 | 63 |
| Rank of State | 10 | 11 | 14 | 10 | 10 |

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[a] Included in miscellaneous.

[b] The value of pottery products for Virginia for 1905, 1906, and 1907 could not be included in the State total without disclosing individual figures.

[c] Stove lining included in fire brick in 1903.

*Clay products of the United States, by States, from 1903 to 1907*—Continued.

WISCONSIN.

| Product. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Brick: | | | | | |
| Common— | | | | | |
| Quantity | 181,722,000 | 186,292,000 | 186,531,000 | 170,496,000 | 158,602,000 |
| Value | $1,193,360 | $1,230,620 | $1,260,066 | $1,109,386 | $1,019,522 |
| Average per M | $6.57 | $6.61 | $6.76 | $6.51 | $6.43 |
| Vitrified— | | | | | |
| Quantity | (a) | .......... | .......... | .......... | (a) |
| Value | (a) | .......... | .......... | .......... | (a) |
| Average per M | $12.00 | .......... | .......... | .......... | $8.04 |
| Front— | | | | | |
| Quantity | 6,794,000 | 8,438,000 | 4,917,000 | 5,384,000 | 4,106,000 |
| Value | $62,857 | $86,688 | $49,275 | $52,038 | $43,387 |
| Average per M | $9.25 | $10.27 | $10.02 | $9.67 | $10.57 |
| Fancy or ornamental.value | (a) | (a) | $1,048 | (a) | (a) |
| Draintile.....do | $34,556 | $54,831 | $57,576 | $51,143 | $49,832 |
| Pottery: | | | | | |
| Earthenware and stoneware, value | $13,586 | $13,075 | $11,950 | $11,470 | $8,832 |
| Miscellaneous.....value | $3,037 | $5,780 | $2,200 | $3,305 | $6,246 |
| Total value | $1,307,396 | $1,390,994 | $1,382,115 | $1,227,342 | $1,127,819 |
| Number of operating firms reporting | 158 | 159 | 157 | 147 | 138 |
| Rank of State | 22 | 20 | 24 | 25 | 26 |

[a] Included in "Miscellaneous."

## CLAY.

### INTRODUCTION.

The clay-mining industry in 1907 appears to have been in a prosperous condition, there being an increase in both quantity and value of the clay mined and sold during the year, the former increasing 7.71 per cent and the latter 6.26 per cent. This gain, as shown elsewhere, was principally in the fire clay. Slip clay was the only other variety of clay to show an increase in value. Brick clay was reported separately for the first time. This clay, although occurring in every State, is generally burned by the miner and is not often sold as clay; hence it is not reported from every State represented in the table.

The clay given in these tables is only such as is sold as clay by the miner and does not include the clay burned into clay products by the miner. The clay thus sold is a small quantity compared with the quantity of clay consumed, and includes mainly clay used for pottery, paper clay, and fire clay. Potters, especially makers of high-grade ware, usually purchase their clay, and fire-brick makers do so to some extent. The makers of the coarser products generally mine their own clay, which is not included here.

### PRODUCTION.

In the following tables will be found statements of the clay mined and shipped by the miner as such in 1906 and 1907:

*Clay mined and sold in the United States in 1906, in short tons.*

| State. | Kaolin. | | Paper clay. | | Slip clay. | | Ball clay. | | Fire clay. | | Stoneware clay. | | Miscellaneous.[a] | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | | | | | | | | | 25,871 | $16,564 | | | 20,000 | $4,000 | 45,871 | $20,564 |
| Arizona[b] | (c) | (c) | | | | | (c) | (c) | 16,966 | 21,917 | | | 4,618 | 1,975 | 42,258 | 126,912 |
| California | | | | | | | | | 44,213 | 53,918 | (c) | (c) | | | 57,413 | 67,418 |
| Colorado | | | | | | | | | 19,761 | 27,318 | (c) | (c) | 50,390 | 40,272 | 71,796 | 70,597 |
| Delaware | (c) | (c) | | | | | | | (c) | (c) | (c) | (c) | | | 29,766 | 122,661 |
| Georgia | | | 32,552 | $141,765 | | | | | 6,070 | 14,568 | (c) | (c) | (c) | (c) | 38,979 | 156,690 |
| Illinois | (c) | (c) | | | (c) | (c) | (c) | (c) | 44,989 | 50,793 | 44,950 | $37,603 | 34,060 | 20,845 | 139,704 | 131,272 |
| Indiana | | | | | | | | | 52,474 | 52,200 | (c) | (c) | 3,500 | 1,750 | 63,279 | 62,974 |
| Iowa | | | | | | | | | 355 | 560 | | | 1,650 | 1,350 | 2,005 | 1,910 |
| Kentucky | | | | | | | (c) | (c) | 31,658 | 24,912 | (c) | (c) | 7,250 | 11,000 | 45,910 | 59,780 |
| Maryland | (c) | (c) | | | | | | | 13,628 | 24,234 | 1,525 | 1,894 | 1,260 | 950 | 18,413 | 39,078 |
| Massachusetts | | | | | | | | | 1,585 | 4,224 | | | 2,826 | 2,218 | 4,411 | 6,442 |
| Michigan | | | | | 1,989 | $5,455 | | | | | | | | | 1,989 | 5,455 |
| Missouri | (c) | (c) | | | | | | | 158,845 | 346,437 | 3,486 | 2,616 | 2,617 | 14,500 | 165,258 | 365,793 |
| Montana | | | | | | | | | 1,615 | 3,598 | | | | | 1,615 | 3,598 |
| New Jersey | | | (c) | (c) | | | 1,908 | $9,081 | 360,411 | 523,835 | 23,523 | 41,787 | 84,302 | 106,041 | 470,174 | 680,999 |
| New York | | | | | (c) | (c) | | | 2,962 | 3,508 | (c) | (c) | 1,124 | 806 | 6,864 | 9,933 |
| North Carolina | 11,803 | $90,036 | | | | | | | (c) | (c) | 140 | 65 | 48 | 72 | 12,010 | 90,358 |
| Ohio | | | | | 1,435 | 1,625 | | | 200,159 | 210,832 | 43,175 | 33,702 | 4,226 | 5,142 | 248,995 | 251,301 |
| Pennsylvania | 19,281 | 109,040 | 6,831 | 38,663 | | | | | 300,386 | 392,545 | 1,767 | 543 | 57,773 | 31,540 | 386,038 | 572,331 |
| South Carolina | | | 36,550 | 162,025 | | | | | (c) | (c) | | | 7,600 | 10,600 | 44,665 | 175,351 |
| Tennessee | | | | | | | 25,811 | 64,522 | 20,656 | 23,904 | 3,188 | 3,216 | 9,283 | 12,755 | 58,938 | 104,397 |
| Texas | | | | | | | | | 888 | 2,570 | (c) | (c) | 1,929 | 2,889 | 3,167 | 5,984 |
| Utah | (c) | (c) | | | | | | | 4,688 | 11,166 | | | | | 4,713 | 11,416 |
| Vermont | 4,992 | 36,125 | | | | | | | (c) | (c) | | | | | 5,392 | 37,325 |
| Virginia | (c) | (c) | | | | | | | (c) | (c) | | | 1,102 | 659 | 2,903 | 24,354 |
| West Virginia | | | | | | | | | 53,457 | 36,052 | (c) | (c) | | | 54,207 | 36,377 |
| Wyoming | | | | | | | | | | | | | 719 | 3,986 | 719 | 3,986 |
| Other States[d] | 15,861 | 134,251 | 30 | 255 | 18,003 | 24,466 | 26,454 | 125,470 | 18,835 | 32,356 | 25,107 | 29,348 | 342 | 342 | (e) | (e) |
| Total | 51,937 | 369,452 | 75,963 | 342,708 | 21,427 | 31,546 | 54,173 | 199,073 | 1,380,472 | 1,878,011 | 146,861 | 150,774 | 296,619 | 273,692 | 2,027,452 | 3,245,256 |
| Average value per ton | | 7.11 | | 4.51 | | 1.47 | | 3.67 | | 1.36 | | 1.03 | | 0.92 | | 1.60 |

[a] Including bentonite, brick clay, plaster clay, puddled clay, sagger clay, sewer-pipe clay, shale, terra-cotta clay, and wad clay.
[b] Including Connecticut, Florida, Idaho, Indian Territory, New Mexico, North Dakota, Oregon, South Dakota, Washington, and Wisconsin.
[c] Included in "Other States."
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

*Clay mined and sold in the United States in 1907, in short tons.*

| State. | Kaolin. | | Paper clay. | | Slip clay. | | Ball clay. | | Fire clay. | | Stoneware clay. | | Brick clay. | | Miscellaneous.[a] | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | | | | | | | | | 79,668 | $59,416 | | | | | 34,000 | $12,100 | 113,668 | $71,516 |
| Arizona [b] | (c) | (c) | | | 1,698 | $5,373 | (c) | (c) | 1,624 | 10,634 | (c) | (c) | (c) | (c) | 2,277 | 3,234 | 35,841 | 195,791 |
| California | | | | | | | | | 73,138 | 90,327 | 4,436 | $5,459 | (c) | (c) | 10,919 | 11,919 | 94,932 | 109,949 |
| Colorado | | | | | | | | | 22,396 | 27,312 | (c) | (c) | 36,205 | $31,069 | 29,578 | 17,615 | 89,210 | 78,091 |
| Georgia | | | 28,503 | $126,253 | | | | | 15,080 | 14,060 | 984 | 1,784 | (c) | (c) | 2,170 | 2,151 | 47,737 | 147,248 |
| Illinois | (c) | (c) | | | | | (c) | (c) | 66,525 | 55,545 | 23,633 | 20,150 | 8,500 | 7,139 | 24,787 | 20,079 | 123,775 | 105,703 |
| Indiana | | | | | (c) | (c) | | | 64,004 | 63,826 | 3,331 | 3,831 | | | 19,730 | 20,780 | 87,565 | 89,687 |
| Iowa | | | | | | | | | 3,732 | 2,841 | | | (c) | (c) | 6,055 | 1,535 | 10,012 | 4,691 |
| Kentucky | | | | | | | (c) | (c) | 37,415 | 41,877 | (c) | (c) | | | 5,808 | 8,687 | 47,732 | 68,528 |
| Maryland | (c) | (c) | | | | | | | 7,818 | 9,448 | 2,256 | 3,028 | 4,879 | 6,850 | 1,950 | 550 | 18,441 | 29,876 |
| Massachusetts | | | | | | | | | 1,800 | 4,298 | | | 6,367 | 2,327 | 2,707 | 2,757 | 10,874 | 9,382 |
| Missouri | 307 | $2,194 | | | | | | | 167,043 | 428,349 | 2,510 | 1,673 | (c) | (c) | 425 | 10,625 | 171,302 | 443,553 |
| Montana | | | | | | | | | 6,835 | 12,384 | | | | | | | 6,835 | 12,384 |
| New Jersey | | | | | (c) | (c) | 3,666 | $16,918 | 318,603 | 485,613 | 21,108 | 44,704 | 18,876 | 16,517 | 75,885 | 103,496 | 440,138 | 675,248 |
| New Mexico | | | | | | | | | 16,326 | 18,446 | | | | | | | 16,326 | 18,446 |
| New York | | | | | (c) | (c) | | | 699 | 5,412 | | | | | 1,001 | 1,381 | 4,255 | 11,902 |
| North Carolina | 11,035 | 85,505 | | | | | | | (c) | (c) | 143 | 93 | (c) | (c) | 50 | 50 | 11,938 | 86,491 |
| Ohio | | | | | (c) | (c) | | | 217,746 | 201,215 | 47,312 | 32,956 | 6,066 | 7,767 | 9,033 | 8,637 | 292,157 | 265,575 |
| Pennsylvania | 18,428 | 109,839 | 4,785 | 23,808 | | | | | 296,278 | 433,714 | 4,916 | 4,884 | 44,885 | 31,777 | 13,328 | 14,121 | 382,620 | 618,143 |
| South Carolina | | | 32,860 | 143,624 | | | | | (c) | (c) | | | | | 3,633 | 10,400 | 37,273 | 158,341 |
| Tennessee | | | | | (c) | (c) | 25,653 | 70,088 | 4,754 | 5,541 | 11,608 | 13,049 | (c) | (c) | 15,747 | 21,211 | 58,645 | 111,287 |
| Texas | | | | | | | | | 1,725 | 6,583 | 617 | 845 | (c) | (c) | 377 | 1,505 | 2,735 | 8,941 |
| Utah | | | | | | | | | 10,054 | 26,898 | | | | | | | 10,054 | 26,898 |
| Vermont | (c) | (c) | | | | | | | (c) | (c) | | | | | | | 8,045 | 46,943 |
| Virginia | (c) | (c) | | | | | | | 636 | 1,657 | | | (c) | (c) | 22 | 8 | 2,008 | 11,415 |
| Washington | | | | | (c) | (c) | | | (c) | (c) | (c) | (c) | | | 950 | 2,350 | 1,754 | 4,623 |
| West Virginia | | | | | | | | | 56,528 | 34,952 | (c) | (c) | | | | | 57,128 | 35,252 |
| Wyoming | | | (c) | (c) | | | | | | | | | | | 636 | 2,386 | 679 | 2,644 |
| Other States [d] | 17,875 | 142,773 | 43 | 258 | 18,627 | 32,552 | 23,094 | 108,509 | 4,035 | 14,350 | 2,206 | 4,120 | 10,737 | 8,557 | | | (e) | (e) |
| Total | 47,645 | 340,311 | 66,191 | 293,943 | 20,325 | 37,925 | 52,413 | 195,515 | 1,474,462 | 2,054,698 | 125,060 | 136,576 | 136,515 | 112,003 | 261,068 | 277,577 | 2,183,679 | 3,448,548 |
| Average value per ton | | 7.14 | | 4.44 | | 1.87 | | 3.73 | | 1.39 | | 1.09 | | 0.82 | | 1.06 | | 1.58 |

[a] Including bentonite, plaster clay, sagger clay, sewer-pipe clay, shale, terra-cotta clay, wad clay, and clay for medicinal use.
[b] Including Delaware, Florida, Idaho, Michigan, Minnesota, North Dakota, Oklahoma, Oregon, South Dakota, and Wisconsin.
[c] Included in "Other States."
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

From these tables it will be seen that the clay mined and sold as such in the United States in 1907 amounted to 2,183,679 short tons, valued at $3,448,548, a gain of 156,227 tons, or 7.71 per cent, in quantity and of $203,292, or 6.26 per cent, in value. The gains in 1906 were 221,319 tons, or 12.25 per cent, and $477,250, or 17.24 per cent.

New Jersey continued to be the leading clay-producing State both in quantity of clay mined and in value of product, though in both quantity and value there was a slight falling off in 1907. This State reported 440,138 tons of clay, valued at $675,248, or 19.58 per cent of the total in 1907, as compared with 470,174 tons, valued at $680,999, or 20.98 per cent of the total in 1906. This was a decrease in 1907 of 30,036 tons and $5,751. Fire clay is the principal variety of clay mined in New Jersey, its value being 71.92 per cent of the State total. Small quantities of slip, ball, and stoneware clays were also mined in New Jersey in 1907, and brick clay to the value of $16,517 was sold.

Pennsylvania was second in quantity and value of clay mined in both 1906 and 1907, reporting 386,038 short tons of clay, valued at $572,331, or 17.64 per cent of the total for 1906, and 382,620 tons, valued at $618,143, or 17.92 per cent of the total value for 1907. This is a loss of only 0.89 of 1 per cent in quantity and a gain of 8 per cent in value. Missouri, third in value of clay mined in 1907, was fourth in quantity, and Ohio was third in quantity and fourth in value. Missouri's product was 12.86 per cent of the total value in 1907, and 11.27 per cent of the total in 1906. The gain in value in this State over 1906 was $77,760, or 21.26 per cent. Ohio also showed a gain in both quantity and value, the product in 1906 being valued at $251,301 and in 1907 at $265,575, a gain of $14,274, or 5.68 per cent.

In 1906 only 5 States showed decreases in value of clay mined; in 1907, however, 9 showed decreases, as follows: Georgia, Illinois, Maryland, New Jersey, North Carolina, South Carolina, Virginia, West Virginia, and Wyoming.

Fire clay was the only variety of clay that increased in both quantity and value, the quantity increasing from 1,380,472 short tons in 1906 to 1,474,462 tons in 1907, a gain of 93,990 tons, or 6.81 per cent, and the value from $1,878,011 in 1906 to $2,054,698 in 1907, a gain of $176,687, or 9.41 per cent. New Jersey was the leading fire clay producing State, reporting 318,603 tons, valued at $485,613, which is a decrease from 1906. Pennsylvania and Missouri were second and third in both years, both showing an increase in 1907 over 1906.

Kaolin decreased in value $29,141, or 7.89 per cent; paper clay $48,765, or 14.23 per cent; and stoneware clay, $14,198, or 9.42 per cent.

The average price per ton increased slightly in 1907 in every variety of clay, except paper clay, in which it showed a decline from $4.51 in 1906 to $4.44 in 1907. The largest increase was in slip clay—from $1.47 to $1.87 per ton. The other prices varied only a few cents from those of 1906, and the general average for 1907 was practically the same as in 1906—$1.58 per ton in 1907 and $1.60 in 1906.

In addition to the clay included in these tables 300,000 tons were reported from California as having been used in making a dam at Salton Sea.

## IMPORTS.

The following table shows the imports of clay from 1903 to 1907, inclusive:

*Classified imports of clay for consumption, 1903–1907, in short tons.*

| Year. | Kaolin or china clay. | | All other clays. | | | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unwrought. | | Wrought. | | Common blue. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 157,088 | $898,573 | 32,691 | $152,018 | 2,725 | $36,211 | 10,165 | $110,794 | 202,669 | [a]$1,198,418 |
| 1904 | 160,046 | 891,708 | 25,402 | 123,241 | 1,363 | 25,026 | 5,263 | 50,364 | 192,074 | 1,090,339 |
| 1905 | 187,803 | 1,019,650 | 30,661 | 151,583 | 1,560 | 38,036 | 5,909 | 54,390 | 225,933 | 1,263,659 |
| 1906 | 223,404 | 1,208,189 | 33,267 | 166,366 | 1,889 | 37,549 | 9,220 | 84,578 | 267,780 | 1,496,682 |
| 1907 | 239,923 | 1,582,893 | 31,196 | 145,698 | 2,520 | 81,155 | 12,378 | 110,686 | 286,017 | 1,920,432 |

[a] Includes clay not otherwise provided for, valued at $822, but for which no quantity is reported.

It will be seen that the clay imports have been increasing since 1903 until 1907 shows the greatest quantity and value yet recorded. The average value of the kaolin imported in 1907 was $6.60 per ton; in 1906 it was $5.41 per ton.

# LIME AND SAND-LIME BRICK.

By Edwin C. Eckel.

## INTRODUCTION.

Until recently statistics relative to the lime industry were reported in the volume on Mineral Resources in the chapter on stone, and the sand-lime brick production was reported in the chapter on clay products. This practice had grown up quite naturally, as the earlier statistics on lime were gathered merely incidentally to the collection of limestone statistics, and the sand-lime brick industry was new and unimportant. The recent growth of both industries, however, seemed to make it desirable to devote a separate section to lime and its products, and accordingly this was done in 1905. This year the same plan has been followed, but additional material is now presented relative to certain technologic features of the industries reported on. This is possible owing to the complete responses made by individual producers to requests for information as to fuel used, uses of their lime, and other particulars.

## LIME.

### PRODUCTION.

As with most other industries in 1907, the lime production during the first eight or nine months of the year was heavily in excess of the production during the corresponding months of 1906. Shutdowns during the last quarter of the year, however, reduced the total gain in value over the output of 1906 to a relatively small sum while the tonnage produced actually showed a slight decrease

The total lime production of 1907 amounted to 3,084,799 short tons, as compared with an output of 3,198,087 tons in 1906—a decrease of 113,288 tons. The higher prices that obtained during the earlier part of the year, however, operated to bring the value of the 1907 product up to $12,640,512, as compared with $12,480,653 in 1906—an increase of $159,859. The average price per ton in 1907 was $4.10 as against $3.90 per ton in 1906.

In 1907 the number of lime burners reporting operations was 899; in 1906 it was 979.

The following table gives the value of the total lime production in the United States for the years 1896 to 1907, inclusive.

*Value of total production of lime in the United States, 1896–1907.*

| | | | |
|---|---|---|---|
| 1896 | $6,327,900 | 1902 | $9,335,618 |
| 1897 | 6,390,487 | 1903 | 9,255,882 |
| 1898 | 6,886,549 | 1904 | 9,951,456 |
| 1899 | 6,983,067 | 1905 | 10,941,680 |
| 1900 | 6,797,496 | 1906 | 12,480,653 |
| 1901 | 8,204,054 | 1907 | 12,640,512 |

Detailed statistics of lime production during 1906 and 1907, by States, are given in the following table:

*Quantity and value of lime burned in the United States in 1906 and 1907, by States, in short tons.*

1906.

| State. | Quantity. | Value. | Average price per ton. | Number of operators. |
|---|---|---|---|---|
| Alabama | 92,403 | $341,627 | $3.70 | 11 |
| Arizona | 14,084 | 96,470 | 6.85 | 3 |
| Arkansas | 30,348 | 121,953 | 4.02 | 8 |
| California | 73,941 | 601,557 | 8.19 | 20 |
| Colorado | 6,595 | 32,020 | 4.86 | 3 |
| Connecticut | 90,457 | 411,853 | 4.55 | 6 |
| Florida | 18,362 | 71,382 | 3.89 | 3 |
| Georgia | 18,903 | 72,840 | 3.85 | 5 |
| Idaho | 5,932 | 39,840 | 6.72 | 3 |
| Illinois | 121,546 | 534,118 | 4.39 | 24 |
| Indiana | 114,819 | 353,648 | 3.08 | 17 |
| Iowa | 17,497 | 78,366 | 4.48 | 11 |
| Kansas | 1,893 | 10,217 | 5.40 | 6 |
| Kentucky | 9,784 | 28,081 | 2.87 | 8 |
| Maine | 228,208 | 1,066,275 | 4.67 | 9 |
| Maryland | 127,863 | 350,460 | 2.74 | 48 |
| Massachusetts | 119,267 | 563,100 | 4.72 | 10 |
| Michigan | 68,133 | 281,465 | 4.13 | 13 |
| Minnesota | 19,920 | 93,555 | 4.70 | 4 |
| Missouri | 207,334 | 916,693 | 4.42 | 28 |
| Montana | 4,745 | 30,098 | 6.34 | 7 |
| New Jersey | 42,714 | 187,978 | 4.40 | 25 |
| New Mexico | 1,790 | 9,975 | 5.57 | 4 |
| New York | 114,620 | 519,855 | 4.54 | 37 |
| North Carolina | 5,896 | 41,468 | 7.03 | 5 |
| Ohio | 331,972 | 1,100,133 | 3.31 | 39 |
| Oregon | 3,934 | 32,383 | 8.23 | 9 |
| Pennsylvania | 624,060 | 1,857,754 | 2.98 | 425 |
| South Dakota | 3,666 | 23,930 | 6.53 | 5 |
| Tennessee | 83,047 | 307,165 | 3.70 | 16 |
| Texas | 41,183 | 192,527 | 4.67 | 8 |
| Utah | 17,461 | 86,518 | 4.95 | 12 |
| Vermont | 32,755 | 167,393 | 5.11 | 9 |
| Virginia | 104,468 | 382,083 | 3.66 | 24 |
| Washington | 59,094 | 347,924 | 5.89 | 8 |
| West Virginia | 98,447 | 257,333 | 2.61 | 48 |
| Wisconsin | 225,633 | 769,808 | 3.41 | 48 |
| Wyoming | 396 | 4,265 | 10.77 | 3 |
| Nevada | 14,917 | 96,538 | 16.00 | 7 |
| Oklahoma (Indian Territory) | | | 7.70 | |
| Rhode Island | | | 7.79 | |
| South Carolina | | | 4.87 | |
| Total | 3,198,087 | 12,480,653 | 3.90 | 979 |

*Quantity and value of lime burned in the United States in 1906 and 1907, by States, in short tons*—Continued.

1907.

| State. | Quantity. | Value. | Average price per ton. | Number of operators. |
|---|---|---|---|---|
| Alabama | 85,909 | $368,902 | $4.29 | 12 |
| Arizona | 12,825 | 84,262 | 6.66 | 5 |
| Arkansas | 33,472 | 159,566 | 4.77 | 11 |
| California | 84,981 | 691,851 | 8.14 | 27 |
| Colorado | 5,679 | 28,798 | 5.07 | 3 |
| Connecticut | 81,433 | 358,052 | 4.39 | 7 |
| Georgia | 18,349 | 70,826 | 3.85 | 6 |
| Idaho | 5,964 | 49,022 | 8.22 | 4 |
| Illinois | 124,784 | 559,305 | 4.48 | 22 |
| Indiana | 107,964 | 335,151 | 3.10 | 15 |
| Iowa | 19,944 | 84,011 | 4.21 | 8 |
| Kansas | 4,124 | 18,131 | 4.40 | 6 |
| Kentucky | 4,670 | 14,945 | 3.20 | 8 |
| Maine | 159,494 | 747,947 | 4.68 | 7 |
| Maryland | 103,423 | 324,316 | 3.14 | 41 |
| Massachusetts | 119,072 | 596,778 | 5.01 | 10 |
| Michigan | 65,822 | 276,534 | 4.20 | 12 |
| Minnesota | 20,450 | 88,900 | 4.35 | 4 |
| Missouri | 190,300 | 877,970 | 4.61 | 27 |
| Montana | 4,217 | 25,340 | 6.01 | 7 |
| New Jersey | 34,043 | 167,159 | 4.91 | 22 |
| New Mexico | 485 | 3,866 | 7.97 | 4 |
| New York | 137,111 | 652,205 | 4.76 | 39 |
| North Carolina | 5,000 | 24,010 | 4.80 | 4 |
| Ohio | 322,917 | 1,239,912 | 3.84 | 36 |
| Oregon | 4,095 | 39.738 | 9.70 | 6 |
| Pennsylvania | 655,166 | 2,075,842 | 3.17 | 366 |
| South Dakota | 3,673 | 24,895 | 6.78 | 4 |
| Tennessee | 66,699 | 263,323 | 3.95 | 16 |
| Texas | 38,101 | 186,372 | 4.89 | 9 |
| Utah | 12,671 | 68,085 | 5.37 | 13 |
| Vermont | 47,369 | 254,281 | 5.36 | 12 |
| Virginia | 115,155 | 447,307 | 3.89 | 26 |
| Washington | 35,913 | 238,568 | 6.64 | 9 |
| West Virginia | 107,895 | 290,298 | 2.69 | 34 |
| Wisconsin | 219,644 | 733,996 | 3.34 | 46 |
| Wyoming | 282 | 3,220 | 11.41 | 3 |
| Florida | 25,704 | 166,828 | 6.02 | 8 |
| Hawaii | | | 15.00 | |
| Nevada | | | 20.00 | |
| Oklahoma | | | 7.86 | |
| Rhode Island | | | 6.80 | |
| South Carolina | | | 5.43 | |
| Total | 3,084,799 | 12,640,512 | 4.10 | 899 |

## USES OF THE LIME PRODUCED.

In the following table the total lime production of 1906 and 1907 is classified according to the uses to which the product was put as reported by the burners. There is, of course, abundant room for error in a summary of this kind, for much of the product is handled through middlemen, and the manufacturers in that case can not be certain of how their product is used. It is believed, however, that even in its present imperfect form the table contains data of much value to the lime trade.

*Production of lime in the United States in 1906 and 1907, by uses, in short tons.*

1906.

| Use. | Quantity. | Value. | Use. | Quantity. | Value. |
|---|---|---|---|---|---|
| Building lime | 2,506,452 | $10,247,579 | Glue factories | 1,050 | $3,000 |
| Hydrated lime | 120,357 | 479,079 | Chemical works | 79,932 | 282,400 |
| Sand-lime brick | 19,737 | 85,845 | Acetate lime | 2,400 | 12,000 |
| Slag cement | 175 | 500 | Lead smelters | 10,750 | 55,375 |
| Quicklime brick | 1,003 | 4,391 | Sheep dipping | 70 | 525 |
| Sugar factories | 28,678 | 128,547 | Tanneries | 7,472 | 37,780 |
| Fertilizer | 300,024 | 713,336 | Alkali works | 2,450 | 9,000 |
| Steel works | 11,517 | 46,100 | Ground lime | 18,627 | 58,220 |
| Paper mills | 53,266 | 197,277 | Cyaniding plants | 2,222 | 13,890 |
| Glass works | 20,558 | 62,216 | Soap | 6,000 | 27,000 |
| Ammonia works | 2,049 | 5,643 | | | |
| Water purification | 2,965 | 10,950 | Total | 3,197,754 | 12,480,653 |

1907.

| Use. | Quantity. | Value. | Use. | Quantity. | Value. |
|---|---|---|---|---|---|
| Building lime | 1,762,784 | $7,738,211 | Fertilizer | 269,608 | $712,410 |
| Hydrated lime | 140,135 | 657,636 | Dealers—uses not specified | 396,337 | 1,540,473 |
| Alkali works | 10,747 | 36,355 | Other purposes[a] | 118,310 | 436,128 |
| Chemical works | 173,422 | 691,096 | | | |
| Paper mills | 153,681 | 572,838 | | | |
| Sugar factories | 24,640 | 110,940 | Total | 3,084,799 | 12,640,512 |
| Tanneries | 35,135 | 144,425 | | | |

[a] Includes lime for sand-lime brick, slag cement, steel works, glass works, smelters, sheep dipping, manufacture of soap, cyanide plants, glue factories, etc.

On comparison of these statistics, it will be seen that they are of service primarily for determining the relative importance of the structural and of the chemical uses of lime. The figures for 1906 showed that the lime sold for structural uses—building lime, hydrated lime, for sand-lime brick manufacture, for slag cement, etc.—amounted to 2,647,724 short tons out of a total lime production of 3,198,087 tons, leaving 550,363 tons for the various chemical industries in which lime is used. According to the reports for 1907, on the assumption that most of the lime handled by dealers was marketed as building lime, the total lime used for structural purposes was apparently about 2,300,000 tons; hence about 785,000 tons were used in the chemical industries.

## FUELS USED IN BURNING LIME.

*Kind and quantity of fuel used in burning lime in 1906 and 1907.*

1906.

| Kind of fuel used. | | Quantity of fuel. | Quantity of lime burned. | Number of plants using. |
|---|---|---|---|---|
| | | | *Short tons.* | |
| Wood | cords | 412,359 | 921,073 | 285 |
| Shavings | short tons | 22,945 | 43,677 | 3 |
| Coal | do | 357,735 | 1,150,220 | 549 |
| Coke | do | 2,160 | 9,889 | 7 |
| Oil | barrels | 24,486 | 16,921 | 5 |
| Gas | cubic feet | 236,435,000 | 60,760 | 6 |
| Mixed fuels: | | | | |
| Wood | cords | 71,282 | 429,411 | 76 |
| Coal | short tons | 95,960 | | |
| Wood | cords | 300 | 1,120 | 1 |
| Coke | short tons | 150 | | |
| Wood | cords | 300 | 18,286 | 1 |
| Coal | short tons | 2,000 | | |
| Coke | do | 500 | | |
| Coal and coke | do | 9,268 | 28,685 | 9 |
| Coal | do | 37,386 | 128,944 | 9 |
| Gas | cubic feet | 193,543,000 | | |
| Total | | | 2,808,986 | 951 |

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*Kind and quantity of fuel used in burning lime in 1906 and 1907*—Continued.

1907.

| Kind of fuel used. | Quantity of fuel. | Quantity of lime burned. | Number of plants using. |
|---|---|---|---|
| | | *Short tons.* | |
| Wood.....cords.. | 333,665 | 618,005 | 190 |
| Shavings.....short tons.. | 9,827 | 20,149 | 2 |
| Coal.....do.... | 520,726 | 1,287,855 | 487 |
| Coke.....do.... | 3,436 | 30,535 | 7 |
| Oil.....barrels.. | 26,374 | 15,815 | 9 |
| Gas.....cubic feet.. | 157,721,000 | 28,510 | 7 |
| Mixed fuels: | | | |
| Wood.....cords.. | 76,009 | 352,877 | 75 |
| Coal.....short tons.. | 113,335 | | |
| Coal and coke.....do.... | 8,686 | 55,795 | 7 |
| Coal.....do.... | 12,824 | 66,356 | 4 |
| Gas.....cubic feet.. | 198,602,000 | | |
| Coal.....short tons.. | 3,560 | 12,657 | 1 |
| Shavings.....do.... | 4,772 | | |
| Manure.....do.... | 2,402 | | |
| Total..... | ..... | 2,488,554 | 789 |

The total quantity of the various kinds of fuel consumed in the domestic lime industry during 1906 and 1907 was, therefore, as follows:

*Total fuel consumed in burning lime in 1906 and 1907.*

| | 1906. | 1907. | | 1906. | 1907. |
|---|---|---|---|---|---|
| Wood.....cords.. | 484,241 | 409,674 | Coke....short tons.. | 4,098 | 4,406 |
| Shavings.short tons.. | 22,945 | 14,599 | Gas......cubic feet.. | 429,978,000 | 356,323,000 |
| Coal.....do.... | 501,081 | 646,885 | Oil.....barrels.. | 24,486 | 26,374 |

The "gas" in this table includes both natural gas and producer gas, as can be determined from its fuel efficiency.

### FUEL CONSUMPTION PER TON OF LIME.

The most valuable use to which the data given above may be put is the determination of the average fuel consumption per short ton of lime burned with different kinds of fuel. Disregarding the product from the plants using mixed fuels, these averages are as shown in the following table:

*Fuel consumption per short ton of lime burned in 1906 and 1907.*

| | 1906. | 1907. | | 1906. | 1907. |
|---|---|---|---|---|---|
| Wood.....cord.. | 0.448 | 0.540 | Coke.....short ton.. | 0.219 | 0.113 |
| Shavings.....short ton.. | .525 | .488 | Oil.....barrels.. | 1.447 | 1.668 |
| Coal.....do.... | .311 | .404 | Gas.....cubic feet.. | 3,891 | 5,532 |

### HYDRATED LIME.

Lime-hydrating plants reported as in operation during 1906 and 1907 are classified by States in the following table. The output of hydrated lime in 1906 was 120,357 short tons, valued at $479,079, or $3.98 per barrel; in 1907 it was 140,135 short tons, valued at $657,636, or $4.69 per barrel.

*Number of lime-hydrating plants in operation in 1906 and 1907, by States.*

| State. | 1906. | 1907. | State. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | 1 | 1 | Maine | 1 | 1 |
| Arizona | 1 | 1 | Michigan | 1 | 1 |
| California | ........ | 1 | Missouri | ........ | 2 |
| Colorado | ........ | 1 | New York | 1 | 2 |
| Connecticut | 1 | ........ | Ohio | 8 | 9 |
| Georgia | 2 | 1 | Pennsylvania | 8 | 6 |
| Illinois | ........ | 1 | West Virginia | 1 | 1 |
| Indiana | 2 | 2 | Wisconsin | 1 | 2 |
| Iowa | 1 | ........ | | | |
| Kansas | 1 | 1 | Total | 30 | 33 |

## IMPORTS AND EXPORTS.

The imports of lime for consumption into the United States in 1907 were 15,388 short tons, valued at $86,304, as against 20,692 short tons, valued at $91,241, in 1906, and 22,247 short tons, valued at $84,564, in 1905.

The exports in 1907 were valued at $90,379, as against $101,668 in 1906.

## SAND-LIME BRICK.

### PRODUCTION.

The year 1907 showed an increase of $55,764, or 4.77 per cent, in the value of the sand-lime brick output, the product being valued at $1,225,769, as compared with $1,170,005 in 1906. The common building brick averaged $6.61 per thousand in 1907, as against an average of $6.71 in 1906. The average price per thousand for front brick in 1907 was $10.96, as against $10.42 in 1906.

In the following table statistics are given in detail for 1906 and 1907:

*Production of sand-lime brick in the United States in 1906 and 1907, by States.*

1906.

| State. | Number of operating firms reporting. | Common brick. | | Front brick. | | Fancy brick. | | Blocks, value. | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity (thousands). | Value. | Quantity (thousands). | Value. | Quantity (thousands). | Value. | | |
| Alabama, Kentucky, Mississippi, and Tennessee | 6 | 6,877 | $51,079 | 1,276 | $11,947 | ........ | ........ | ........ | $63,026 |
| Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas | 8 | 14,877 | 96,128 | 1,897 | 17,962 | (a) | (a) | ........ | 114,390 |
| California | 4 | 4,837 | 38,789 | 1,900 | 22,400 | ........ | ........ | ........ | 61,189 |
| Colorado and Idaho | 4 | 509 | 6,043 | 2,191 | 22,743 | ........ | ........ | (a) | 31,464 |
| Delaware, Maryland, and Virginia | 4 | 9,403 | 61,719 | (a) | (a) | ........ | ........ | ........ | 67,119 |
| Florida | 8 | 11,678 | 83,306 | (a) | (a) | ........ | ........ | ........ | 89,306 |
| Georgia | 3 | 5,139 | 37,701 | (a) | (a) | ........ | ........ | ........ | 40,701 |
| Illinois and Wisconsin | 4 | 8,150 | 49,150 | 690 | 6,060 | ........ | ........ | ........ | 55,210 |
| Indiana | 6 | 17,077 | 84,361 | 326 | 2,474 | (a) | (a) | ........ | 86,880 |
| Iowa | 3 | 3,921 | 28,271 | (a) | (a) | (a) | (a) | (a) | 38,255 |
| Michigan | 11 | 27,281 | 162,879 | 1,796 | 12,022 | (a) | (a) | ........ | 174,921 |
| New Jersey | 3 | 6,520 | 49,143 | ........ | ........ | ........ | ........ | (a) | 50,143 |
| New York | 9 | 21,288 | 169,257 | 1,910 | 22,064 | ........ | ........ | ........ | 191,321 |
| North Carolina | 3 | 3,147 | 22,225 | (a) | (a) | ........ | ........ | ........ | 32,975 |
| Ohio | 4 | 1,232 | 7,049 | (a) | (a) | ........ | ........ | ........ | 10,184 |
| Pennsylvania | 7 | 6,673 | 50,211 | 978 | 12,710 | ........ | ........ | ........ | 62,921 |
| Other States[b] | ........ | ........ | ........ | 2,718 | 32,963 | 121 | $3,473 | $5,876 | (c) |
| Total | 87 | 148,609 | 997,311 | 15,682 | 163,345 | 121 | 3,473 | 5,876 | 1,170,005 |
| Average value per M | | | 6.71 | ........ | 10.42 | ........ | 28.70 | ........ | ........ |

[a] Included in other States.

[b] Includes all products made by less than three producers in one State, to prevent disclosing individual operations.

[c] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

*Production of sand-lime brick in the United States in 1906 and 1907, by States*—Con.

### 1907.

| State. | Number of operating firms reporting. | Common brick. | | Front brick. | | Fancy brick. | | Blocks, value. | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity (thousands). | Value. | Quantity (thousands). | Value. | Quantity (thousands). | Value. | | |
| Alabama, Kentucky, and Mississippi | 5 | 8,840 | $58,060 | 568 | $5,000 | ...... | ...... | ...... | $63,060 |
| Arizona, North Dakota, and Washington | 3 | 2,039 | 16,469 | 11 | 200 | ...... | ...... | $300 | 16,969 |
| Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas | 13 | 20,442 | 144,028 | 2,754 | 31,319 | 40 | $800 | ...... | 176,147 |
| California | 4 | 5,263 | 42,915 | 1,390 | 20,085 | ...... | ...... | (a) | 63,150 |
| Colorado and Idaho | 4 | 2,235 | 23,351 | 3,625 | 37,414 | 12 | 513 | 1,059 | 62,337 |
| Delaware, Maryland, and Virginia | 5 | 10,259 | 67,948 | 20 | 200 | ...... | ...... | ...... | 68,148 |
| Florida | 6 | 16,421 | 106,871 | (a) | (a) | ...... | ...... | ...... | 109,275 |
| Georgia | 4 | 11,167 | 78,086 | (a) | (a) | ...... | ...... | ...... | 89,582 |
| Illinois and Wisconsin | 4 | 8,854 | 51,241 | 390 | 3,120 | ...... | ...... | ...... | 54,361 |
| Indiana | 8 | 14,841 | 86,927 | 1,300 | 10,600 | ...... | ...... | ...... | 97,527 |
| Iowa | 3 | 6,295 | 45,471 | (a) | (a) | ...... | ...... | (a) | 55,618 |
| Michigan | 13 | 25,488 | 158,606 | (a) | (a) | ...... | ...... | ...... | 172,840 |
| New Jersey | 3 | (a) | (a) | (a) | (a) | ...... | ...... | ...... | 22,792 |
| New York | 6 | 10,925 | 64,904 | 1,173 | 10,558 | ...... | ...... | ...... | 75,462 |
| North Carolina | 3 | 4,068 | 29,458 | 755 | 9,350 | ...... | ...... | ...... | 38,808 |
| Ohio | 5 | 1,726 | 11,283 | ...... | ...... | ...... | ...... | ...... | 11,283 |
| Pennsylvania | 5 | 6,402 | 41,515 | (a) | (a) | ...... | ...... | ...... | 48,410 |
| Other States [b] | ...... | 630 | 3,780 | 5,186 | 60,375 | ...... | ...... | 3,963 | (c) |
| Total | 94 | 155,895 | 1,030,913 | 17,172 | 188,221 | 52 | 1,313 | 5,322 | 1,225,769 |
| Average value per M | ...... | ...... | 6.61 | ...... | 10.96 | ...... | 25.25 | ...... | ...... |

[a] Included in other States.

[b] Includes all products made by less than three producers in one State, to prevent disclosing individual operations.

[c] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

*Value of production of sand-lime brick in the United States, 1903–1907.*

| Year. | Number of plants. | Value of product. | Year. | Number of plants. | Value of product. |
|---|---|---|---|---|---|
| 1903 | 16 | $155,040 | 1906 | 87 | $1,170,005 |
| 1904 | 57 | 463,128 | 1907 | 94 | 1,225,769 |
| 1905 | 84 | 972,064 | | | |

# SAND AND GRAVEL.

## PRODUCTION.

The production of sand and gravel in 1907 amounted to 41,851,918 short tons, valued at $14,492,069. In 1906 the production was 32,932,002 short tons, valued at $12,698,208. The increase in 1907 was 8,919,916 short tons in quantity and $1,793,861 in value.

The large increase in quantity as compared with the increase in value was due to the inclusion in the figures of large quantities of sand and gravel used as ballast and for filling on the lines of railroads. This material is taken out by the railroads themselves and the value as reported ranges from 8 to 20 cents per cubic yard. Glass sand and molding sand command the highest prices, the average prices per ton in 1907 being $1.53 for glass sand and 67 cents for molding sand. Building sand, including sand used for concrete, mortar, and all structural purposes, had an average value of 32 cents per ton in 1907.

The price of sand varies so with the treatment of the material after being taken from the mine or pit that a statement of average price can hardly be taken as representing the market conditions. Much of the sand, especially the building sand, is dredged from the Ohio, Tennessee, Mississippi, Missouri, Potomac, and Delaware rivers, the shores of the Great Lakes, and from the sea beaches of Long Island. This sand is sometimes sold as dredged, being simply loaded from the dredge for shipment on scows or barges, and represents the lowest reported value to the producer. Sand washed, dried, screened, and then loaded for shipment commands a higher price. Sand crushed from stone has a higher value than natural sand, and sand for glass making, which calls for especially pure sand, commands the highest price.

Pennsylvania leads in the value of sand and gravel production, followed by New York, Ohio, Illinois, and New Jersey in the order named. There was a general increase in production in 1907 as compared with 1906, an exception being noted in the case of furnace sand, in which there was a slight decrease.

The following table gives the production of sand and gravel in the United States in 1906 and 1907 by States and uses, in short tons:

*Production of sand and gravel in the United States in 1906 and 1907, by States and uses, in short tons.*

## 1906.

| State. | Glass sand. | | Molding sand. | | Building sand. | | Fire sand. | | Engine sand. | | Furnace sand. | | Other sand. | | Gravel. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | | | 61,295 | $24,000 | 86,443 | $48,818 | | | 9,000 | $2,500 | 6,000 | $4,800 | | | 53,299 | $49,798 | 216,037 | $129,916 |
| Arkansas | | | 545 | 520 | 125,680 | 62,752 | | | 51,975 | 14,521 | | | 28,025 | $17,731 | 8,200 | 8,688 | 214,425 | 104,212 |
| California | 7,324 | $6,124 | 4,987 | 6,064 | 16,624 | 6,675 | | | 25,446 | 7,130 | | | 1,132 | 1,615 | 179,861 | 81,816 | 235,374 | 109,424 |
| Colorado | 750 | 938 | 12,139 | 7,717 | 30,417 | 9,672 | 3,000 | $1,000 | 1,000 | 300 | | | 900 | 900 | | | 48,206 | 20,527 |
| Connecticut | | | 1,446 | 1,426 | 13,187 | 4,040 | | | | | | | | | | | 14,633 | 5,466 |
| Delaware | | | 220 | 110 | 31,878 | 12,751 | | | 30,327 | 12,131 | 22,416 | 10,161 | 30 | 38 | | | 84,871 | 35,191 |
| Georgia | 6,000 | 6,000 | 57,550 | 18,988 | 227,972 | 73,177 | 1,875 | 900 | 26,575 | 6,575 | 2,625 | 1,710 | 5,400 | 3,666 | 7,800 | 6,800 | 335,797 | 117,816 |
| Hawaii | | | | | | | | | | | | | 5,985 | 9,294 | 2,375 | 1,750 | 8,360 | 11,044 |
| Illinois | 238,178 | 156,684 | 372,307 | 216,087 | 868,014 | 314,071 | 1,070 | 428 | 70,000 | 27,400 | 86,490 | 38,038 | 64,903 | 32,068 | 956,597 | 258,265 | 2,657,559 | 1,043,041 |
| Indiana | 38,940 | 29,259 | 142,252 | 71,368 | 753,542 | 310,806 | 65 | 20 | 103,305 | 13,016 | 114,405 | 17,799 | 2,816,567 | 149,389 | 2,252,699 | 443,695 | 6,221,775 | 1,035,352 |
| Iowa | | | 4,952 | 5,152 | 127,271 | 45,158 | 1,800 | 1,400 | 8,550 | 2,100 | | | 14,975 | 4,863 | 27,125 | 15,707 | 184,673 | 74,380 |
| Kansas | | | 288,155 | 65,310 | | | | | 5,000 | 1,000 | | | 34 | 14 | 729 | 438 | 293,918 | 66,762 |
| Kentucky | 2,400 | 2,040 | 67,825 | 36,484 | 303,902 | 153,547 | | | 35,512 | 11,448 | 3,000 | 2,300 | 12,485 | 5,674 | 161,663 | 81,643 | 586,877 | 293,136 |
| Louisiana | | | | | 152,545 | 96,657 | | | 113,839 | 20,328 | | | 113,741 | 20,942 | 561,609 | 310,522 | 941,734 | 448,449 |
| Maryland | 10,000 | 14,000 | 13,200 | 6,000 | 463,531 | 186,605 | | | 80 | 56 | | | 28,865 | 19,375 | 98,541 | 59,761 | 614,217 | 285,797 |
| Massachusetts | 6,829 | 31,738 | 4,190 | 4,350 | 81,168 | 38,076 | 8,000 | 5,200 | | | | | 3,620 | 6,410 | 9,846 | 7,318 | 113,653 | 93,092 |
| Michigan | 600 | 3,000 | 61,387 | 26,108 | 403,199 | 127,937 | | | 4,000 | 400 | 5,000 | 2,500 | 51,005 | 12,140 | 72,598 | 25,614 | 597,789 | 197,699 |
| Minnesota | | | 27,470 | 25,181 | 82,041 | 38,474 | | | | | | | 5,685 | 5,470 | 29,824 | 8,816 | 145,020 | 77,941 |
| Mississippi | | | 251 | 375 | 8,637 | 2,875 | | | | | | | 8,300 | 4,460 | 51,375 | 25,550 | 68,563 | 33,260 |
| Missouri | 101,862 | 65,393 | 89,249 | 51,922 | 2,276,485 | 722,913 | 9,808 | 5,970 | 62,533 | 12,531 | 500 | 280 | 49,364 | 29,673 | 474,857 | 147,696 | 3,064,658 | 1,036,378 |
| Montana | | | | | 2,000 | 900 | | | | | | | | | | | 2,000 | 900 |
| Nebraska | | | | | 148,465 | 34,000 | | | 19,860 | 2,830 | | | 7,942 | 953 | 1,150 | 525 | 177,417 | 38,308 |
| New Jersey | 102,658 | 83,031 | 422,794 | 290,054 | 533,681 | 195,249 | 105,014 | 101,700 | 47,993 | 17,094 | 22,750 | 11,300 | 261,148 | 188,152 | 123,424 | 71,735 | 1,619,462 | 958,315 |
| New Mexico | | | | | | | | | | | | | 1,250 | 1,500 | | | 1,250 | 1,500 |
| New York | 1,500 | 1,200 | 215,368 | 151,268 | 3,369,194 | 1,045,844 | 22,647 | 7,110 | 32,528 | 14,948 | 7,019 | 3,678 | 59,102 | 22,574 | 390,127 | 126,547 | 4,097,485 | 1,373,169 |
| Ohio | 71,329 | 71,246 | 816,540 | 555,910 | 796,472 | 275,799 | 16,600 | 12,000 | 16,348 | 7,443 | 71,204 | 92,148 | 55,394 | 43,328 | 580,387 | 196,568 | 2,424,274 | 1,254,442 |
| Oregon | | | | | 91,843 | 60,000 | | | | | | | | | 154,407 | 47,644 | 246,250 | 107,644 |
| Pennsylvania | 342,967 | 510,910 | 555,449 | 399,091 | 2,288,006 | 808,679 | 7,949 | 6,851 | 154,387 | 110,809 | 77,797 | 46,094 | 367,397 | 291,786 | 1,438,923 | 306,591 | 5,232,875 | 2,480,811 |
| Tennessee | | | 23,599 | 15,443 | 276,195 | 127,497 | 1,425 | 675 | 28,250 | 10,700 | 2,875 | 1,250 | 15,710 | 6,680 | 283,952 | 96,818 | 632,006 | 259,063 |
| Texas | | | 2,687 | 1,859 | 150,616 | 74,106 | | | 6,700 | 820 | | | 45,007 | 4,657 | 109,100 | 77,925 | 314,110 | 159,367 |
| Vermont | | | 1,500 | 712 | 1,987 | 1,225 | | | | | | | 77,350 | 9,375 | 750 | 300 | 81,587 | 11,612 |
| Virginia | | | 26,654 | 15,466 | 272,396 | 91,265 | 1,000 | 500 | 4,370 | 1,970 | 21,376 | 8,028 | 8,602 | 4,072 | 780 | 650 | 335,178 | 121,951 |
| Washington | | | 3,300 | 6,200 | 114,032 | 46,473 | | | | | | | | | 176,239 | 92,052 | 293,571 | 144,725 |
| West Virginia | 158,093 | 227,225 | 10,616 | 7,745 | 123,259 | 62,346 | | | 31,844 | 21,267 | | | 12,322 | 8,400 | 58,724 | 13,301 | 394,858 | 340,374 |
| Wisconsin | | | 55,973 | 33,907 | 122,718 | 70,020 | | | 1,260 | 1,260 | 800 | 800 | 6,200 | 14,074 | 114,659 | 51,413 | 301,610 | 171,474 |
| Other States[a] | | | 27,203 | 18,334 | 44,888 | 18,125 | | | 8,189 | 1,949 | | | 1,260 | 2,668 | 48,390 | 14,594 | 129,930 | 55,670 |
| Total | 1,089,430 | 1,208,788 | 3,371,103 | 2,063,151 | 14,388,378 | 5,166,532 | 180,253 | 143,754 | 898,871 | 322,526 | 444,257 | 240,886 | 4,129,700 | 922,031 | 8,430,010 | 2,630,540 | 32,932,002 | 12,698,208 |

[a] Includes Florida, Maine, North Carolina, Oklahoma, South Carolina, Utah, and Wyoming.

*Production of sand and gravel in the United States in 1906 and 1907, by States and uses, in short tons*—Continued.

1907.

| State. | Glass sand. | | Molding sand. | | Building sand. | | Fire sand. | | Engine sand. | | Furnace sand. | | Other sand. | | Gravel. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | ...... | ...... | 57,683 | $25,698 | 161,073 | $73,829 | ...... | ...... | 9,000 | $3,000 | 6,720 | $4,500 | ...... | ...... | 77,183 | $62,845 | 311,659 | $169,872 |
| Arkansas | 43 | $32 | 43 | 20 | 120,434 | 57,197 | ...... | ...... | 20,356 | 6,208 | ...... | ...... | 1,707 | $670 | 22,530 | 17,550 | 165,113 | 81,677 |
| California | 11,064 | 8,179 | 6,278 | 5,076 | 84,433 | 29,154 | ...... | ...... | 35,720 | 12,500 | ...... | ...... | 26,971 | 21,802 | 1,080,467 | 102,095 | 1,244,933 | 178,866 |
| Colorado | 2,000 | 2,500 | 20,168 | 6,986 | 2,897 | 944 | 500 | $750 | ...... | ...... | 4,800 | 2,880 | 21,989 | 6,505 | 16,102 | 4,508 | 68,456 | 25,073 |
| Connecticut | ...... | ...... | 945 | 2,553 | 28,870 | 23,640 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 29,815 | 26,193 |
| Delaware | ...... | ...... | 28,610 | 12,687 | 15,285 | 9,500 | ...... | ...... | 49,250 | 19,700 | ...... | ...... | 53,000 | 21,200 | 1,137 | 800 | 147,282 | 63,887 |
| Florida | ...... | ...... | 3,643 | 1,641 | 8,000 | 2,000 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 4,155 | 2,968 | 15,798 | 6,609 |
| Georgia | 4,800 | 4,800 | 22,695 | 10,735 | 179,255 | 59,309 | ...... | ...... | 10,000 | 2,000 | ...... | ...... | 9,140 | 5,547 | 5,200 | 4,400 | 231,090 | 86,791 |
| Illinois | 235,716 | 152,619 | 372,884 | 237,149 | 1,067,776 | 419,450 | 6,668 | 2,667 | 113,742 | 29,091 | 16,000 | 12,350 | 940,746 | 133,090 | 1,797,459 | 381,237 | 4,550,991 | 1,367,653 |
| Indiana | 30,500 | 23,000 | 110,432 | 65,495 | 727,069 | 193,915 | 65 | 20 | 142,806 | 24,050 | 75,781 | 11,563 | 3,093,777 | 192,035 | 1,438,462 | 297,640 | 5,618,892 | 807,718 |
| Iowa | ...... | ...... | 6,633 | 7,508 | 214,005 | 69,856 | ...... | ...... | 25,945 | 5,285 | 3,000 | 1,200 | 93,405 | 9,771 | 118,796 | 16,881 | 461,784 | 110,501 |
| Kansas | ...... | ...... | ...... | ...... | 265,512 | 66,314 | ...... | ...... | 4,050 | 600 | ...... | ...... | 10,900 | 1,705 | 276,163 | 48,694 | 556,625 | 117,313 |
| Kentucky | 7.400 | 4,592 | 40,119 | 27,498 | 219,963 | 137,016 | 1,200 | 900 | 9,596 | 4,327 | ...... | ...... | 5,785 | 4,241 | 152,729 | 85,376 | 436,792 | 263,950 |
| Louisiana | ...... | ...... | ...... | ...... | 130,275 | 17,784 | ...... | ...... | 21,580 | 2,800 | ...... | ...... | 184,153 | 32,804 | 897,742 | 389,536 | 1,233,750 | 442,924 |
| Maryland | 13,370 | 13,215 | 4,000 | 5,100 | 394,203 | 144,308 | ...... | ...... | ...... | ...... | ...... | ...... | 680 | 830 | 175,006 | 104,505 | 587,759 | 268,048 |
| Massachusetts | 7,500 | 37,734 | 8,485 | 4,418 | 130,072 | 62,483 | 8,500 | 5,525 | 50 | 32 | ...... | ...... | 18,320 | 10,872 | 27,832 | 20,213 | 200,759 | 141,277 |
| Michigan | 4,300 | 8,600 | 54,172 | 24,190 | 451,646 | 157,150 | 6,000 | 3,000 | 1,534 | 153 | 3,858 | 3,133 | 173,724 | 12,187 | 329,407 | 81,182 | 1,024,641 | 289,595 |
| Minnesota | ...... | ...... | 24,575 | 27,324 | 87,437 | 38,577 | ...... | ...... | 2,587 | 259 | 50 | 25 | 17,505 | 9,117 | 285,538 | 55,048 | 417,692 | 130,350 |
| Mississippi | ...... | ...... | 447 | 295 | 68,700 | 21,500 | ...... | ...... | 900 | 600 | ...... | ...... | 3,150 | 650 | 96,218 | 52,818 | 169,415 | 75,863 |
| Missouri | 138,483 | 92,898 | 48,314 | 32,668 | 1,899,822 | 435,441 | 15.738 | 8,979 | 34,500 | 6,803 | 15,000 | 7.500 | 48,760 | 27,051 | 874,663 | 179,634 | 3,075,280 | 790,974 |
| Nebraska | ...... | ...... | ...... | ...... | 261,702 | 41,258 | ...... | ...... | 28,713 | 3,648 | ...... | ...... | 82,908 | 8,778 | 1,267 | 543 | 374,590 | 54,227 |
| New Jersey | 87,140 | 73,914 | 746,102 | 381,403 | 784,060 | 197,996 | 82,153 | 81,963 | 38,920 | 14,611 | 8,131 | 3,257 | 213,900 | 231,742 | 251,430 | 60,373 | 2,211,836 | 1,045,259 |
| New Mexico | ...... | ...... | ...... | ...... | 662 | 550 | ...... | ...... | ...... | ...... | ...... | ...... | 1,000 | 1,000 | 207,816 | 49,174 | 209,478 | 50,724 |
| New York | ...... | ...... | 693,293 | 539,674 | 3,633,726 | 925,028 | 24,086 | 7,826 | 47,862 | 23,385 | 2,997 | 1,436 | 46,235 | 18,624 | 806,697 | 251,548 | 5,254,896 | 1,767,521 |
| North Carolina | ...... | ...... | 885 | 573 | 3,500 | 1,580 | 110 | 18 | ...... | ...... | ...... | ...... | ...... | ...... | 250 | 20 | 4,745 | 2,191 |
| Ohio | 95,449 | 104,127 | 683,714 | 521,494 | 1,219,225 | 442,469 | 13,077 | 9,046 | 41,257 | 15,585 | 122,801 | 98,235 | 125,901 | 40,010 | 677,377 | 285,071 | 2,978,801 | 1,516,037 |
| Oklahoma | ...... | ...... | ...... | ...... | 40,800 | 12,780 | ...... | ...... | ...... | ...... | ...... | ...... | 4,700 | 865 | 63,000 | 8,861 | 108,500 | 22,506 |
| Oregon | ...... | ...... | 2,250 | 1,300 | 197,542 | 123,708 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 304,350 | 164,414 | 504,142 | 288,422 |
| Pennsylvania | 370,977 | 489,989 | 561,980 | 398,691 | 2,288,586 | 855,567 | 44,662 | 51,245 | 194,986 | 145,935 | 103,127 | 63,078 | 701,101 | 430,893 | 1,534,029 | 347,170 | 5,799,448 | 2,782,568 |
| South Carolina | 3,000 | 2,400 | 512 | 248 | 1,062 | 670 | ...... | ...... | ...... | ...... | ...... | ...... | 875 | 700 | 375 | 400 | 5,824 | 4,418 |
| Tennessee | ...... | ...... | 39,155 | 26,141 | 372,936 | 155,031 | ...... | ...... | 41,550 | 11,552 | 14,843 | 9,310 | 9,081 | 3,775 | 316,799 | 107,402 | 794,364 | 313,211 |
| Texas | ...... | ...... | 4,934 | 3,471 | 171,125 | 94,725 | ...... | ...... | 1,875 | 1,200 | ...... | ...... | 6,025 | 5,793 | 99,525 | 37,105 | 283,484 | 142,294 |
| Vermont | ...... | ...... | 968 | 600 | 3,674 | 2,975 | ...... | ...... | ...... | ...... | ...... | ...... | 72,500 | 29,000 | 1,592 | 835 | 78,734 | 33,410 |
| Virginia | 1,246 | 4,535 | 50,627 | 30,377 | 158,715 | 67,160 | ...... | ...... | 10,239 | 4,603 | 10,059 | 4,227 | 24,334 | 9,958 | 13,002 | 2,952 | 268,222 | 123,812 |
| Washington | ...... | ...... | 3,600 | 8,500 | 140,610 | 62,375 | ...... | ...... | 500 | 300 | ...... | ...... | ...... | ...... | 259,250 | 108,625 | 403,960 | 179,800 |
| West Virginia | 171,338 | 225,003 | 8,400 | 6,438 | 151,622 | 70,456 | ...... | ...... | 78,985 | 47,400 | 10,221 | 3,276 | 32,776 | 17,378 | 51,242 | 15,487 | 504,584 | 385,438 |
| Wisconsin | 2,970 | 1,930 | 72,348 | 42,683 | 335,420 | 124,122 | 210 | 136 | 21,618 | 2,162 | 4,000 | 5,600 | 55,485 | 4,844 | 475,608 | 98,917 | 967,669 | 280,394 |
| Other States [a] | ...... | ...... | 3,000 | 2,120 | 27,475 | 14,865 | ...... | ...... | 11,803 | 2,646 | 16,000 | 8,000 | 15,778 | 5,756 | 476,009 | 20,316 | 550,065 | 53,703 |
| Total | 1,187,296 | 1,250,067 | 3,682,494 | 2,460,754 | 16,049,229 | 5,212,682 | 202,969 | 172,075 | 999,924 | 390,495 | 417,388 | 239,570 | 6,096,311 | 1,299,193 | 13,216,407 | 3,467,233 | 41,851,918 | 14,492,069 |

[a] Includes Arizona, Maine, Montana, South Dakota, Utah, and Wyoming.

## IMPORTS.

Sand valued at $94,871 was imported into the United States in 1907, as compared with imports valued at $85,566 in 1906, an increase in 1907 over 1906 of $9,305. In 1905 the value of the sand imported was $48,710.

## LITERATURE.

Papers in which the character, distribution, relation to markets and fuel supplies, and methods of extraction and preparation of glass sand and other sands are discussed are listed below in the order of their dates

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COONS, A. T., Glass sand: Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 1007–1015.

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KÜMMEL, HENRY B., and GAGE, R. B., The glass-sand industry of New Jersey: Ann. Rept. New Jersey Geol. Survey for 1906, 1907, pp. 77–96.

ROCK PRODUCTS, An up-to-date Illinois (sand) plant; January 22, 1908, pp. 63–64.

The following three papers, arranged chronologically, contain much valuable information concerning molding sands. The last paper is probably the most complete that has yet been published concerning the sands of a particular area, and embodies tabulated results of considerable experimental work on the physical properties of the material

MERRILL, G. P., Guide to the study of the collections in the section of applied geology. Nonmetallic minerals: Rept. U. S. Nat. Mus. for 1899, 1901, pp. 474–477.

ECKEL, EDWIN C., Molding sand, its uses, properties, and occurrence. Twenty-first Rept. New York State geologist, 1901, pp. 91–96.

KÜMMEL, H. B., and others, Report upon some molding sands of New Jersey. Ann. Rept. State geologist of New Jersey for 1904, 1905, pp. 189–246.

Three papers recently issued by the United States Geological Survey which deal with sand and gravel as constituents of concrete are the following:

BURCHARD, E. F., Concrete materials produced in the Chicago district: Bull. U. S. Geol. Survey No. 340, 1908.

HUMPHREY, R. L., and JORDAN, W., Jr., Portland cement mortars and their constituent materials: Bull. U. S. Geol. Survey No. 331, 1908.

HUMPHREY, R. L., The strength of concrete beams: Bull. U. S. Geol. Survey No. 344, 1908.

# SLATE.

By A. T. Coons.

## PRODUCTION.

The statistics presented in this report represent the output of slate as reported to this office directly by the quarrymen, and include the quantity and value of the roofing slate sold by them, the quantity and value of mill stock sold by them, and the value of a quantity of slate sold for other purposes. The statistics for the rough material of the mill stock represent the rough slate sold by the quarrymen to mills to be made into a finished product, and those for the manufactured material represent the slate used by the quarrymen in their own mills and sold in the finished or partly finished state. The values given represent the prices free on board at point of shipment.

The figures giving the quantity of mill stock and other slate sold by the quarrymen are shown for the first time in 1907, and it is hoped that their future publication will be of interest and value to the producer, representing as they do with the figures for roofing slate the entire quantity of slate marketed during the year.

During the years since and including 1903 the slate trade has been more or less adversely affected by the financial condition of the country or by labor troubles in the building trades and strikes in slate quarries, by the use of tiles, concrete, shingles, and of patent roofing processes and cheaper grades of material for roofing, by the high price and scarcity of labor, and by a decrease in the export trade.

In 1907 there were nine States producing a commercial output of slate in the United States. These States were Pennsylvania, Vermont, Maine, Virginia, Maryland, New York, California, Arkansas, and New Jersey, named in order of value of output. In 1906 Georgia reported an output and New Jersey had no production in that year.

Slate valued at $6,019,220 was quarried and sold in the United States in 1907. This is an increase of $350,874 over the value reported for 1906, which was $5,668,346. The production in 1907 represents the largest output since 1903, when it was $6,256,885, the largest production of slate in the history of the United States.

In 1907 the production of roofing slate was reported as 1,277,554 squares, valued at $4,817,769; in 1906 the figures reported were 1,214,742 squares, valued at $4,448,786, an increase in 1907 of 62,812 squares in quantity and of $368,983 in value. The increase in average value per square from $3.66 in 1906 to $3.77 in 1907 was 11 cents. Producers generally reported an advance in price per square on account of increased cost of supplies and from scarcity and increased cost of labor.

The value of mill stock, including slate sold for other purposes, decreased from $1,219,560 in 1906 to $1,201,451 in 1907, or $18,109.

Of the States producing mill stock, Vermont and New York decreased in value of output, a loss probably caused by the strike affecting almost all of the quarries in the Vermont-New York region which began in May, 1907, and is still in progress in May, 1908.

As already indicated, the greater part of the slate quarried in the United States is made into roofing slates. Produced almost entirely in the northeastern part of the country, these slates are shipped all over the United States, and are also exported to a small extent. A few years ago, during the strikes in the famous Welsh quarries, they were shipped in large quantities to England and English colonies. The great durability of slate as a roofing material overcomes to a large extent the disadvantages of the weight of the roof and of the cost of slate as compared with cheaper and lighter materials, and also unfavorable labor conditions. The scarcity and high price of shingles also have served to keep slate in favor both for local use and for shipment.

Roofing slate as put on the market is sold by "squares," a square meaning a sufficient number of pieces of slate of any size to cover 100 square feet of surface on a roof, allowing a 3-inch lap. The approximate weight of roofing slate of ordinary thickness is 650 pounds per square, and the slate is generally shipped in carload lots of from 50 to 100 squares per carload, according to the size of the pieces. The sizes of slate in a square vary from 24 by 16 inches to 9 by 7 inches, and the number of pieces necessary for a square varies from 85 to 686, according to the size of the pieces. The thickness of ordinary slate is from one-eighth to three-sixteenths of an inch, slates less than one-eighth commanding less price per square as they are more liable to breakage, while those over three-sixteenths command higher prices.

The price per square depends on the size of the pieces, the quality of the slate, and the uniformity of the pieces as to thickness, smoothness, and straightness. The color of the slates, which varies considerably, also affects the price. Among the distinguishing colors are the black, dark gray, green, and red of Arkansas slates, the very dark gray of California and Maine slates, and of the Maryland-Pennsylvania Peachbottom slates, the black of New Jersey, the red and green of New York, the bluish black, dark gray, and dark green of Pennsylvania, and the dark grays, green, purple, and bluish black of Vermont slates. Some of these slates fade somewhat on exposure to the sun, and are therefore not considered entirely satisfactory by some, though their other roofing properties remain unimpaired. On the other hand, these fading slates are often preferred as giving a softer tone and assisting in producing a roof of more beauty than the brighter slates. Roofing slates of cheaper quality are also made of mottled and ribboned slate, it being possible to conceal these deficiencies of color and appearance under the lap of the slate.

The prices per square of slate of good quality and of ordinary thickness range from $3.75 to $10 free on board at quarries, the highest prices being for New York red slate. Slate inferior in quality or color is quoted as low as $2.75 per square, while squares of selected pieces over three-sixteenths of an inch thick are quoted at much higher prices. The prices per square vary from month to month, and the freight rates, changing according to point of shipment, range from $1 to $1.75 per square to places west of Pittsburg and east of the

Mississippi to nearly $8 per square to San Francisco and along the Pacific coast, the only local source of supply for the West being in Eldorado County, Cal.

Among the uses of slate other than for roofing are for blackboards, school slates, flooring, sinks, laundry tubs, grave vaults, sanitary ware, electrical switchboards, billiard and laboratory table tops, mantels, hearths, and caps. Slate used for these purposes is known as mill stock and is sold either by the quarrymen to milling companies or is milled by the quarry operators who have their own mills. It is generally sold in the form of slabs from 1 to 3 inches thick, the price varying according to the thickness and to the work done on the slab. Maine, Pennsylvania, and Vermont produce nearly all the mill slate, and Pennsylvania reported the only slate that was used in 1907 for blackboards and school slates.

The following table shows the value of roofing and mill slate quarried in the United States in 1906 and 1907, by States:

*Value of roofing, mill, and other slate produced in the United States in 1906 and 1907, by States.*

1906.

| State. | Roofing slate. | | Value of mill stock. | Total value. |
|---|---|---|---|---|
| | Number of squares. | Value. | | |
| **Arkansas** | | | $5,000 | $5,000 |
| **California** | 10,000 | $80,000 | | 80,000 |
| **Georgia** | 1,000 | 5,000 | | 5,000 |
| **Maine** | 18,498 | 100,916 | 137,765 | 238,681 |
| **Maryland** | 25,288 | 129,965 | 1,004 | 130,969 |
| **New York** | 10,788 | 60,000 | 12,360 | 72,360 |
| **Pennsylvania** | 755,966 | 2,710,249 | 811,900 | 3,522,149 |
| **Vermont** | 354,134 | 1,189,799 | 251,531 | 1,441,330 |
| **Virginia** | 39,068 | 172,857 | | 172,857 |
| **Total** | 1,214,742 | 4,448,786 | 1,219,560 | 5,668,346 |

1907.

| State. | Roofing slate. | | Mill stock. | | | | | | Other. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Manufactured. | | Rough. | | Total. | | | |
| | Number of squares. | Value. | Quantity. | Value. | Quantity. | Value | Quantity. | Value. | | |
| | | | Sq. feet. | | Sq. feet. | | Sq. feet. | | | |
| Arkansas | | | | | | | | | [a]$8,500 | $8,500 |
| California | 7,000 | $60,000 | | | | | | | | 60,000 |
| Maine | 16,879 | 91,583 | 404,829 | $145,023 | | | 404,829 | $145,023 | | 236,606 |
| Maryland | 21,815 | 113,665 | | | | | | | 2,395 | 116,060 |
| New Jersey | 2,000 | 8,000 | | | | | | | | 8,000 |
| New York | 11,908 | 81,535 | 13,000 | 1,950 | | | 13,000 | 1,950 | | 83,485 |
| Pennsylvania | 793,466 | 2,987,740 | 3,447,654 | 557,714 | 1,492,839 | $63,039 | 4,940,493 | 620,753 | [b]247,147 | 3,855,640 |
| Vermont | 385,314 | 1,301,576 | 698,317 | 141,130 | 265,594 | 34,553 | 963,911 | 175,683 | | 1,477,259 |
| Virginia | 39,172 | 173,670 | | | | | | | | 173,670 |
| | 1,277,554 | 4,817,769 | 4,563,800 | 845,817 | 1,758,433 | 97,592 | 6,322,233 | 943,409 | 258,042 | 6.019,220 |

[a] Used chiefly for electrical supplies.

[b] Composed of 5,711,105 school slates, valued at $48,152, and 1,531,330 square feet of blackboard material, valued at $198,995.

The quantity and value of blackboard and school slates stated in the preceding table represent not the entire quantity and value of these articles made in 1907, but the quantity and value of the material sold as such by the quarrymen. It is possible that some of the rough milling stock sold to the slate mills by the quarrymen was used for these purposes. This office does not, however, collect slate statistics from manufacturers, but from quarrymen. Were figures from dealers and slate-mill operators included, it would be almost impossible to avoid duplication. On the other hand, it is impossible to obtain the value of rough slate stock from the quarryman who mills his own slate, as the only value the material has to him is its value at the completion of his work.

The following table shows the total value of the slate production of the United States from 1903 to 1907, inclusive:

*Value of slate produced in the United States, 1903–1907, by States.*

| State. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Arkansas | $4,709 | $14,300 | $10,000 | $5,000 | $8,500 |
| California | 70,000 | 39,200 | 40,000 | 80,000 | 60,000 |
| Georgia | ........ | 4,500 | 7,500 | 5,000 | ........ |
| Maine | 231,230 | 181,168 | 224,254 | 238,681 | 236,606 |
| Maryland | 137,631 | 133,972 | 151,215 | 130,969 | 116,060 |
| New Jersey | 33,403 | ........ | 5,360 | ........ | 8,000 |
| New York | 111,998 | 71,543 | 66,646 | 72,360 | 83,485 |
| Pennsylvania | 3,959,906 | 3,633,246 | 3,491,905 | 3,522,149 | 3,855,640 |
| Tennessee | ........ | 607 | ........ | ........ | ........ |
| Utah | ........ | 300 | ........ | ........ | ........ |
| Vermont | 1,592,652 | 1,408,151 | 1,352,541 | 1,441,330 | 1,477,259 |
| Virginia | 115,356 | 130,208 | 146,786 | 172,857 | 173,670 |
| Total | 6,256,885 | 5,617,195 | 5,496,207 | 5,668,346 | 6,019,220 |

The following table shows the value of slate for roofing purposes and for mill stock from 1903 to 1907, inclusive:

*Value of roofing slate and mill stock, 1903–1907.*

| | Roofing slate. | | Value of mill stock. | Total value. |
|---|---|---|---|---|
| | Number of squares. | Value. | | |
| 1903 | 1,378,194 | $5,345,078 | $911,807 | $6,256,885 |
| 1904 | 1,233,757 | 4,669,289 | 947,906 | 5,617,195 |
| 1905 | 1,241,227 | 4,574,550 | 921,657 | 5,496,207 |
| 1906 | 1,214,742 | 4,448,786 | 1,219,560 | 5,668,346 |
| 1907 | 1,277,554 | 4,817,769 | 1,201,451 | 6,019,220 |

The following table shows the average price of roofing slate per square since 1902:

*Average annual price per square of roofing slate for the entire country.*

| | | | |
|---|---|---|---|
| 1902 | $3.45 | 1905 | $3.69 |
| 1903 | 3.88 | 1906 | 3.66 |
| 1904 | 3.78 | 1907 | 3.77 |

## IMPORTS.

Practically no slate is imported into the United States. In 1906 slate valued at $9,471 was imported in the form of mantels, chimney pieces, etc., including $228 for roofing slate; in 1907 the importations were valued at $5,404, of which $5,196 was for chimney pieces, etc., and $208 for roofing slate.

## EXPORTS.

In comparison with the total output the value of roofing slate exported from this country in 1907 was very small, being only $220,995, as against $255,785 in 1906.

## SLATE INDUSTRY BY STATES.

*Arkansas.*—The development of the slate industry in Arkansas is still retarded by lack of transportation facilities. This slate is at present used principally for electrical purposes, although good roofing material may be obtained in the State. The developed deposits are chiefly in Polk and Montgomery counties.

*California.*—There was a decrease in the slate operations in the Eldorado County, Cal., district from 10,000 squares, valued at $80,000, in 1906, to 7,000 squares, valued at $60,000, in 1907.

*Georgia.*—Development work was done at the Rockmart, Polk County, slate deposits in 1907.

*Maine.*—Operations in the Maine slate district were practically the same in 1907 as in 1906, the output for 1907 being valued at $236,606, as compared with $238,681 in 1906, a decrease of $2,075. The decrease was in quantity and value of roofing slate. The average price per square was $5.43, against $5.45 in 1906. The producing localities were Blanchard, Monson, and Brownville, Piscataquis County.

*Maryland.*—The entire output of slate in Maryland in 1907 was obtained from the Peachbottom region at Cardiff, Harford County. There was a decrease in value of $14,909, from $130,969 in 1906 to $116,060 in 1907. The decrease was in the quantity and value of roofing slate. The average value per square was $5.21 in 1907, as against $5.14 in 1906.

*New Jersey.*—The slate properties in Sussex County, N. J., were operated to some extent in 1907.

*New York.*—The output of slate in New York was obtained from Granville, Middle Granville, and Salem, Washington County. The total value increased from $72,360 in 1906 to $83,485 in 1907, a gain of $11,125. The average price per square was $5.56 in 1906 and $6.85 in 1907. This increase in value was on account of a larger quantity of the better quality of red slate sold in 1907.

*Pennsylvania.*—The output of slate from this State amounted to 64.06 per cent of the total value of the slate produced in the United States. This represents 62.02 per cent of the value of the roofing slate and 72.24 per cent of the value of all the other slate produced. The value of the slate output in Pennsylvania in 1906 increased $333,491, from $3,522,149 in 1906 to $3,855,640 in 1907. The increase was both in roofing slate and in mill stock.

In 1906 the output was curtailed by a strike in the Bangor region lasting two months. In 1907 operators reported steady demand equal to or greater than the supply until October and November, when the general financial situation depressed the slate trade somewhat; however, but little stock was left on hand, and many orders were placed for 1908. Prices were higher in 1907 for roofing slate and mill stock.

The roofing-slate output increased from 755,966 squares, valued at $2,710,249, in 1906 to 793,466 squares, valued at $2,987,740, in 1907, an increase of 37,500 squares in quantity and of $277,491 in value. The average price per square was $3.59 in 1906 and $3.77 in 1907, an increase of $0.18 per square. The roofing slate in Pennsylvania comes from York, Lehigh, and Northampton counties. In 1907

Pennsylvania produced 62.11 per cent of the quantity of roofing slate produced in the United States, and Northampton County produced 70.07 per cent of the Pennsylvania output and 43.52 per cent of the total for the United States.

In 1906 other kinds of slate in Pennsylvania, including slabs, blackboards, school slates, and other milled products, were valued at $811,900; in 1907 at $867,900, an increase of $56,000. In 1907 for the first time an attempt was made to separate the quantity of slate sold directly to the mills by the quarrymen from the slate milled by them in their own mills and also to separate the quantity and value of the slate sold by the quarrymen for school slates and blackboards. The results are shown in the tables showing the total slate output.

Pennsylvania is the only State reporting slate sold for blackboards and school slates. The detailed statement of the slate output in Pennsylvania in 1906 and 1907, by counties, is given in the following table:

*Slate production in Pennsylvania in 1906 and 1907, by counties.*

| County. | Number of squares. | Value. | Mill slate. | Total value. |
|---|---|---|---|---|
| 1906. | | | | |
| York | 11,468 | $59,833 | ............ | $59,833 |
| Lehigh | 206,505 | 741,933 | $197,487 | 939,420 |
| Northampton | 537,993 | 1,908,483 | 614,413 | 2,522,896 |
| Total | 755,966 | 2,710,249 | 811,900 | 3,522,149 |
| 1907. | | | | |
| York | 14,769 | 82,286 | ............ | 82,286 |
| Lehigh | 222,752 | 841,389 | [a] 166,224 | 1,007,613 |
| Northampton | 555,945 | 2,064,065 | [b] 701,676 | 2,765,741 |
| Total | 793,466 | 2,987,740 | 867,900 | 3,855,640 |

[a] Represents 731,218 square feet of blackboard material, valued at $88,707; 1,579,737 school slates, valued at $12,792, and 909,621 square feet of mill slate, valued at $64,725.

[b] Represents 800,112 square feet of blackboard material, valued at $110,288; 4,131,368 school slates, valued at $35,360, and 4,030,872 square feet of mill slate, valued at $556,028.

*Vermont.*—Vermont ranks next to Pennsylvania in the production of slate. In 1907 Pennsylvania produced 64.06 per cent of the total value of slate for the United States, and Vermont 24.54 per cent. A labor strike beginning May 1, 1907, caused the output of slate in Vermont to remain practically the same as in 1906. A good demand was reported, which, owing to the strike, could not be supplied. The total value in 1906 was $1,441,330, and in 1907 $1,477,259, a gain for 1907 of $35,929. The gain was in quantity and value of roofing slate; this increased from 354,134 squares, valued at $1,189,799, in 1906, to 385,314 squares, valued at $1,301,576, in 1907, a gain of 31,180 squares in quantity and of $111,777 in value. The average price per square was $3.36 in 1906 and $3.38 in 1907.

The mill stock decreased in value from $251,531 in 1906 to $175,683 in 1907, a loss of $75,848. The slate output of this State was chiefly from Rutland County, a small production being reported from Washington County.

*Virginia.*—A labor strike for about three months curtailed the output of slate in 1907, although the total output remained practically the same as in 1906, being 39,068 squares, valued at $172,857, in 1906, and 39,172 squares, valued at $173,670, in 1907.

# STONE.

By A. T. Coons.

## INTRODUCTION.

As in the chapters on stone published in preceding volumes, the present statistics of the production of stone in the United States include the stone sold by the quarrymen and only such manufactured product as is turned out by the producers themselves.

For many years the cards sent by the United States Geological Survey to quarrymen requesting statistics of building and monumental stone simply asked for the building and monumental stone sold by them; but the replies were so unsatisfactory, the value per unit of measurement differed so widely, even in the same locality and for the same firm as reported for different years, that in order to get figures capable of comparison it was found advisable to separate the rough stone from the dressed stone. By this means it became possible to get statistics capable of comparison, as the average producer sells his output in the same manner each year, and a comparison of the individual reports for different years showed which producers manufacture their stone and which sell it rough. The large quantities of stone sold in the rough make it inadvisable to put a valuation on this class of stone other than the value it bears as it leaves the quarryman's hands—that is, the value free on board at point of shipment in the rough or merely rough-cut condition desired by the purchaser. On the other hand, the stone which is quarried and manufactured by the quarryman himself has no value to him until it is sold by him in its finished state. This method of valuation would appear to tend to give an unfair value to the same stone reported from different States. For example, the Georgia marble is practically all sold rough to the manufacturers, and to its output of 807,000 cubic feet in 1907 was given a value of $864,757, or $1.07 per cubic foot as rough material; on the other hand, by far the greater part of the Vermont marble is dressed by its producers, and to the 1,450,000 cubic feet produced in that State in 1907 was given a dressed-stone value of $4,596,724, or $3.10 per cubic foot. Most of the Vermont granite, however, especially the monumental stone, is sold rough to the manufacturers. In Indiana the celebrated "Bedford" stone is usually shipped direct from quarry to market in the unfinished or partly finished state.

It will thus be seen that, although the desire of the United States Geological Survey is to publish figures of production with as little value of labor added to the value of the raw material as possible, the labor value could only be excluded from the manufactured stone quarried and sold by the quarrymen if the Survey assigned a value to the stone itself. In many cases this would not be possible. Often no unit of measurement is stated, and it is to be regretted that there is not more uniformity in the measurement of stone as sold and reported by the quarrymen. In case of building and monumental stone, rubble, riprap, etc., the quantities are reported in cubic feet, cubic yards, tons, cords, perches, rods, etc. The ton is indefinitely long or short; the cord is from 11,000 to 13,000 pounds; and in many cases where weights are given no regard is had to the specific gravity of the stone, the weight seeming to be arbitrarily fixed by the producer.

In reporting stone for flagging and curbing the lineal measurement and also the weight are used; but the stone, of course, is not of uniform thickness.

In case of crushed stone the usual measurements are the ton, long and short, and the cubic yard, which varies in weight from 2,300 pounds to 3,000 pounds. Squares of 100 square feet are also reported from some localities. It has been possible, however, for the last few years to give the quantity as well as the value of crushed stone, and this quantity has been given in short tons, on account both of the large number of producers reporting in that manner and also of the ease with which the other units may be converted into short tons. The average weight of the cubic yard, as reported by the quarrymen, is 2,500 pounds.

It is also possible to give the number of paving blocks made as well as the value of these blocks. However, the size, and therefore the weight, of these blocks vary considerably.

The quantity as well as the value of stone used for furnace flux has been published for some years.

In this report is published for the first time the quantity as well as the value of the granite produced in Vermont, and it is to be hoped that in the near future it may be possible to obtain the figures of quantity for other States as complete as are those given for Vermont.

Much consideration has been given to the proper statement of the value of the stone production by the United States Geological Survey and by the Survey in cooperation with various State surveys, as those of Illinois, North Carolina, Iowa, and Maryland, and at the office of the United States Census, and the decision has always been to give the value as herein stated, with the hope that ability to publish in the near future the quantity of material sold may do away with any appearance of inconsistency.

## PRODUCTION.

For simplicity of treatment the kinds of stone covered by the figures given in this report are classified as granite, trap rock, sandstone, bluestone, limestone, and marble.

Granite includes true granites and other igneous rocks, as gneiss, mica schist, andesite, syenite, trachyte, quartz porphyry, lava, tufa, diabase, trap rock, basalt, diorite, gabbro, and a small quantity of serpentine. Rocks of these kinds are as a rule quarried commercially in quantities too small to permit their being tabulated separately, but the trap rock output for California, Connecticut, Massachusetts, New York, New Jersey, and Pennsylvania represents an important industry, and it is therefore considered advisable to show the value of this stone separately. The trap rock from California includes a considerable quantity of basalt.

Sandstone includes the quartzites of South Dakota and Minnesota and the fine-grained sandstones of New York and Pennsylvania, known to trade as bluestone. As the bluestone is a product of a separate industry, its production is also shown apart from that of the other sandstone. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstone quarried in Michigan, Ohio, and West Virginia. Neither does the total sandstone value include sandstone crushed into sand and used in the manufacture of glass and as molding sand.

Limestone does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. It includes, however, a small quantity of stone sold locally as marble.

Marble includes a small quantity of serpentine quarried and sold as marble in Georgia, Washington, and Pennsylvania, and also a small quantity of the so-called "onyx" marble or travertine as obtained from caves and other deposits.

The following table shows the value of the different kinds of stone produced in the United States from 1898 to 1907, inclusive:

*Value of the different kinds of stone produced in the United States, 1898–1907.*

| Year. | Granite. | Trap rock. | Sandstone. | Bluestone. | Marble. | Limestone. | Total. |
|---|---|---|---|---|---|---|---|
| 1898 | $9,324,406 | ............ | $4,724,412 | [a]$1,000,000 | $3,629,940 | $9,956,417 | $28,635,175 |
| 1899 | 10,343,298 | $1,275,041 | [b]4,910,111 | 815,284 | 4,011,681 | 13,889,302 | 35,244,717 |
| 1900 | 10,969,417 | 1,706,200 | [b]5,272,865 | 1,198,519 | 4,267,253 | 13,556,523 | 36,970,777 |
| 1901 | 14,266,104 | 1,710,857 | [b]6,974,199 | 1,164,481 | 4,965,699 | 18,202,843 | 47,284,183 |
| 1902 | 16,083,475 | 2,181,157 | [b]9,430,958 | 1,163,525 | 5,044,182 | 20,895,385 | 54,798,682 |
| 1903 | 15,703,793 | 2,732,294 | [b]9,482,802 | 1,779,457 | 5,362,686 | 22,372,109 | 57,433,141 |
| 1904 | 17,191,479 | 2,823,546 | [b]8,482,162 | 1,791,729 | 6,297,835 | 22,178,964 | 58,765,715 |
| 1905 | 17,563,139 | 3,074,554 | [b]8,075,149 | 1,931,625 | 7,129,071 | 26,025,210 | 63,798,748 |
| 1906 | 18,562,806 | 3,736,571 | [b]7,147,439 | 2,021,898 | 7,582,938 | 27,327,142 | 66,378,794 |
| 1907 | 18,064,708 | 4,594,103 | [b]6,753,762 | 2,117,916 | 7,837,685 | 31,737,631 | 71,105,805 |

[a] Estimated.

[b] Does not include the value of grindstones and whetstones.

From this table it will be seen that in the last decade the value of the stone produced in the United States has increased from $28,635,175 in 1898 to $71,105,805 in 1907, the increase being $42,470,630, or 148 per cent.

There has been an increase in value of output for each year during this time, but the increase has not been regular, the years 1899 and 1900, 1903 and 1904 showing comparatively small differences in output; the trade in these years was influenced by labor strikes in the building trades and by the general financial condition of the country. It is noticeable, however, that for 1907, a year of markedly unsettled financial and trade conditions, there was an increase of $4,727,011, or

7 per cent, from $66,378,794 in 1906 to $71,105,805 in 1907. This increase was chiefly in crushed stone, the stone used directly as building stone decreasing in value. The chief increase in the years preceding 1907 was also in the crushed-stone output and, in 1905, also of the limestone used as a furnace flux. During this time the greater number of producers, especially the small quarrymen, reported increased cost of labor, scarcity of good labor, and greater cost for fuel and supplies. The selling prices have increased slightly from year to year.

There was also in 1907 a noticeable decrease in the number of producers of stone; a great many of the smaller producers were idle, and of the large producers nearly all, except the producers of crushed stone, had a decrease in production.

In 1907 trap rock, marble, and limestone increased in value of output, and granite and sandstone, including bluestone, decreased.

Granite represented 25.41 per cent of the total output and decreased in value from $18,562,806 in 1906 to $18,064,708 in 1907, a loss of $498,098. This loss was in building stone, the other products showing an increase.

Trap rock represented 6.46 per cent of the total and increased $857,532, or from $3,736,571 in 1906 to $4,594,103 in 1907. The trap-rock output is principally crushed stone.

Sandstone, including bluestone, represented 12.48 per cent of the total, and decreased in value from $9,169,337 in 1906 to $8,871,678 in 1907, a loss of $297,659. Bluestone produced in New York and Pennsylvania increased slightly in value from $2,021,898 in 1906 to $2,117,916 in 1907, a gain of $96,018. Sandstone, exclusive of bluestone, decreased $393,677, or from $7,147,439 in 1906 to $6,753,762 in 1907.

Marble, valued at $7,837,685 in 1907, represented 11.02 per cent of the total stone output; in 1906 the value of marble was $7,582,938, an increase of $254,747 for 1907.

Limestone represented 44.63 per cent of the total stone production in 1907, the value being $31,737,631; in 1906 the value was $27,327,142, a gain for 1907 of $4,410,489. This gain was in the value of crushed stone and in stone used for blast furnace flux.

The following table shows the value of the various kinds of stone produced in 1906 and 1907, by States and Territories:

*Value of various kinds of stone produced in 1906 and 1907, by States and Territories.*

### 1906.

| State or Territory. | Granite. | Trap rock. | Sandstone. | Marble. | Limestone. | Total value. |
|---|---|---|---|---|---|---|
| Alabama | | | $40,467 | $85,000 | $579,344 | $704,811 |
| Alaska | | | | (a) | | (a) |
| Arizona | $32,042 | | 33,149 | | 40 | 65,231 |
| Arkansas | 118,903 | | 55,703 | 16,900 | 48,844 | 240,350 |
| California | 740,784 | $688,423 | 642,166 | 103,048 | 80,205 | 2,254,626 |
| Colorado | 65,402 | | 286,544 | | 373,158 | 725,104 |
| Connecticut | 974,024 | 411,345 | (b) | | 1,171 | 1,386,540 |
| Delaware | 146,346 | | | | | 146,346 |
| Florida | | | | | 1,450 | 1,450 |
| Georgia | 792,315 | | | 919,356 | 16,042 | 1,727,713 |
| Hawaii | 23,346 | | | | | 23,346 |
| Idaho | 400 | | 11.969 | | 12,600 | 24,969 |
| Illinois | | | 19,125 | | 2,942,331 | 2,961,456 |
| Indiana | | | 30,740 | | 3,725,565 | 3,756,305 |
| Indian Territory | | | 615 | | 44,622 | 45,237 |
| Iowa | | | 5,601 | | 493,815 | 499,416 |
| Kansas | | | 42,809 | | 849,203 | 892,012 |
| Kentucky | | | 125,123 | | 795,408 | 920,531 |
| Maine | 2,560,021 | | | | 2,000 | 2,562,021 |
| Maryland | 883,881 | | 9,533 | 176,495 | 170,046 | 1,239,955 |
| Massachusetts | 3,327,416 | 462,795 | 260,721 | 271,934 | 10,750 | 4,333,616 |
| Michigan | | | 65,395 | | 656,269 | 721,664 |
| Minnesota | 626,069 | | 285,633 | | 632,115 | 1,543,817 |
| Missouri | 150,009 | | 20,951 | (c) | 1,988,334 | 2,159,294 |
| Montana | 114,005 | | 37,462 | | 141,082 | 292,549 |
| Nebraska | | | 6,899 | | 276,381 | 283,280 |
| Nevada | | | | 5,000 | | 5,000 |
| New Hampshire | 818,131 | | | | | 818,131 |
| New Jersey | 101,224 | 856,886 | 215,142 | | 221,141 | 1,394,393 |
| New Mexico | | | 42,574 | 500 | 125,493 | 168,567 |
| New York | 304,048 | 623,435 | [d,e]1,905,892 | 557,954 | 2,204,724 | 5,596,053 |
| North Carolina | 778,847 | | 3,531 | | 30,583 | 812,961 |
| North Dakota | | | 44 | | | 44 |
| Ohio | | | 1,426,645 | | 3,025,038 | 4,451,683 |
| Oklahoma | 18,847 | | 40,246 | | 127,361 | 186,454 |
| Oregon | 58,961 | | 25,950 | | 7,480 | 92,391 |
| Pennsylvania | 349,453 | 693,687 | [d]2,724,874 | 171,632 | 4,865,130 | 8,804,776 |
| Rhode Island | 622,812 | | | | 678 | 623,490 |
| South Carolina | 247,998 | | | | | 247.998 |
| South Dakota | | | 145,966 | | 10,400 | 156,366 |
| Tennessee | | | 14,136 | 635,821 | 481,952 | 1,131,909 |
| Texas | 168,061 | | 111,533 | | 239,125 | 518,719 |
| Utah | 4,948 | | 37,529 | 1,400 | 248,868 | 292,745 |
| Vermont | 2,934,825 | | | 4,576,913 | 14.728 | 7,526,466 |
| Virginia | 340,900 | | 5,100 | | 260,343 | 606,343 |
| Washington | 459,975 | | 169,500 | 59,985 | 49,192 | 738,652 |
| West Virginia | | | 113,369 | | 628,602 | 741,971 |
| Wisconsin | 798,213 | | 181,986 | | 891,746 | 1,871,945 |
| Wyoming | 600 | | 24,715 | 1,000 | 53,783 | 80,098 |
| Total | [f]18,562,806 | 3,736,571 | 9,169,337 | 7,582,938 | 27,327,142 | 66,378,794 |

[a] Included with Washington.
[b] Included with New York.
[c] Included in limestone.
[d] Includes bluestone.
[e] Includes a small output for Connecticut.
[f] Includes a small value for trap rock and other igneous rocks.

*Value of various kinds of stone produced in 1906 and 1907, by States and Territories*—Continued.

## 1907.

| State or Territory. | Granite. | Trap rock. | Sandstone. | Marble. | Limestone. | Total value. |
|---|---|---|---|---|---|---|
| Alabama |  |  | $48,673 | $85,475 | $694,699 | $828,847 |
| Alaska |  |  |  | 38,110 |  | 38,110 |
| Arizona | $13,700 |  | 158,435 |  | 64,975 | 237,110 |
| Arkansas | 168,996 |  | 94,275 |  | 52,207 | 315,478 |
| California | 1,306,324 | $1,029,749 | 437,738 | 183,285 | 177,333 | 3,134,429 |
| Colorado | 67,134 |  | 299,443 |  | 502,751 | 869,328 |
| Connecticut | 591,153 | 459,953 | (a) |  | 1,476 | 1,052,582 |
| Delaware | 158,192 |  |  |  |  | 158,192 |
| Florida |  |  |  |  | 15,000 | 15,000 |
| Georgia | 858,603 |  |  | 864,757 | 22,278 | 1,745,638 |
| Hawaii | 19,599 |  |  |  |  | 19,599 |
| Idaho | 25,942 |  | 24,001 | (b) | 15,900 | 65,843 |
| Illinois |  |  | 14,996 |  | 3,774,346 | 3,789,342 |
| Indiana |  |  | 15,425 |  | 3,624,126 | 3,639,551 |
| Iowa |  |  | 3,542 |  | 560,582 | 564,124 |
| Kansas |  |  | 46,831 |  | 813,748 | 860,579 |
| Kentucky |  |  | 98,450 | 12,500 | 891,500 | 1,002,450 |
| Maine | 2,146,420 |  |  |  | 1,350 | 2,147,770 |
| Maryland | 1,183,753 |  | 13,859 | 98,918 | 142,825 | 1,439,355 |
| Massachusetts | 2,328,777 | 432,604 | 243,323 | 212,438 | 1,837 | 3,218,979 |
| Michigan |  |  | 53,003 |  | 760,333 | 813,336 |
| Minnesota | 546,603 |  | 300,204 |  | 735,319 | 1,582,126 |
| Missouri | 136,405 |  | 35,289 | (c) | 2,153.917 | 2,325,611 |
| Montana | 102,050 |  | 39,216 |  | 124,690 | 265,956 |
| Nebraska |  |  | 11,609 |  | 312,630 | 324,239 |
| New Hampshire | 647,721 |  |  |  |  | 647,721 |
| New Jersey | 75,757 | 995,436 | 177,667 |  | 274,452 | 1,523,312 |
| New Mexico | 167,294 |  | 12,450 | [d] 7,535 | 193,732 | 381,011 |
| New York | 289,722 | 915,395 | [e] [f] 1,978,117 | 911,951 | 2,898,520 | 6,993,705 |
| North Carolina | 906,476 |  | 4,105 |  | 22,328 | 932,909 |
| North Dakota |  |  | 3,260 |  |  | 3,260 |
| Ohio |  |  | 1,591,148 |  | 3,566,822 | 5,157,970 |
| Oklahoma | 24,550 |  | 43,403 | 16,805 | 189,568 | 274,326 |
| Oregon | 117,625 |  | 3,904 |  | 5,750 | 127,279 |
| Pennsylvania | 366,679 | 760,966 | [f] 2,064,913 | 118,539 | 5,821,275 | 9,132,372 |
| Rhode Island | 674,148 |  |  |  | 750 | 674,898 |
| South Carolina | 129,377 |  |  |  |  | 129,377 |
| South Dakota | 690 |  | 143,585 |  | 11,600 | 155,875 |
| Tennessee |  |  | 16,523 | 688,148 | 385,450 | 1,090,121 |
| Texas | 122,158 |  | 108,047 |  | 267,757 | 497,962 |
| Utah | 5,240 |  | 24,298 | 2,500 | 306,344 | 338,382 |
| Vermont | 2,693,889 |  |  | 4,596,724 | 23,126 | 7,313,739 |
| Virginia | 398,426 |  | (g) |  | 362,062 | 760,488 |
| Washington | 562,352 |  | 295,585 | (h) | 62,317 | 920,254 |
| West Virginia |  |  | [i] 197,926 |  | 855,941 | 1,053,867 |
| Wisconsin | 1,228,863 |  | 236,183 |  | 1,027,095 | 2,492,141 |
| Wyoming | 90 |  | 32,252 |  | 18,920 | 51,262 |
| Total | 18,064,708 | 4,594,103 | [f] 8,871,078 | 7,837,685 | 31,737,631 | 71,105,805 |

[a] Small value included with New York.
[b] Small value included with New Mexico.
[c] Included in Missouri limestone.
[d] Includes small values for Idaho and Washington.
[e] Includes small value for Connecticut.
[f] Includes bluestone.
[g] Small value included with West Virginia.
[h] Small value included with New Mexico.
[i] Includes small value for Virginia.

The following table shows the rank of States and Territories in 1906 and 1907, according to value of production, and the percentage of the total produced by each State or Territory:

*Rank of States and Territories in 1906 and 1907, according to value of production, and percentage of total produced by each State or Territory.*

| 1906. | | | | 1907. | | | |
|---|---|---|---|---|---|---|---|
| Rank of State. | State or Territory. | Total value. | Percentage of total. | Rank of State. | State or Territory. | Total value. | Percentage of total. |
| 1 | Pennsylvania | $8,804,776 | 13.27 | 1 | Pennsylvania | $9,132,372 | 12.84 |
| 2 | Vermont | 7,526,466 | 11.34 | 2 | Vermont | 7,313,739 | 10.29 |
| 3 | New York [a] | 5,596,053 | 8.43 | 3 | New York [c] | 6,993,705 | 9.84 |
| 4 | Ohio | 4,451,683 | 6.71 | 4 | Ohio | 5,157,970 | 7.25 |
| 5 | Massachusetts | 4,333,616 | 6.53 | 5 | Illinois | 3,789,342 | 5.33 |
| 6 | Indiana | 3,756,305 | 5.66 | 6 | Indiana | 3,639,551 | 5.12 |
| 7 | Illinois | 2,961,456 | 4.46 | 7 | Massachusetts | 3,218,979 | 4.53 |
| 8 | Maine | 2,562,021 | 3.86 | 8 | California | 3,134,429 | 4.41 |
| 9 | California | 2,254,626 | 3.40 | 9 | Wisconsin | 2,492,141 | 3.51 |
| 10 | Missouri | 2,159,294 | 3.25 | 10 | Missouri | 2,325,611 | 3.27 |
| 11 | Wisconsin | 1,871,945 | 2.82 | 11 | Maine | 2,147,770 | 3.02 |
| 12 | Georgia | 1,727,713 | 2.60 | 12 | Georgia | 1,745,638 | 2.46 |
| 13 | Minnesota | 1,543,817 | 2.33 | 13 | Minnesota | 1,582,126 | 2.23 |
| 14 | New Jersey | 1,394,393 | 2.10 | 14 | New Jersey | 1,523,312 | 2.14 |
| 15 | Connecticut | 1,386,540 | 2.09 | 15 | Maryland | 1,439,355 | 2.02 |
| 16 | Maryland | 1,239,955 | 1.87 | 16 | Tennessee | 1,090,121 | 1.53 |
| 17 | Tennessee | 1,131,909 | 1.71 | 17 | West Virginia [d] | 1,053,867 | 1.48 |
| 18 | Kentucky | 920,531 | 1.39 | 18 | Connecticut [e] | 1,052,582 | 1.48 |
| 19 | Kansas | 892,012 | 1.34 | 19 | Kentucky | 1,002,450 | 1.41 |
| 20 | New Hampshire | 818,131 | 1.23 | 20 | North Carolina | 932,909 | 1.31 |
| 21 | North Carolina | 812,961 | 1.23 | 21 | Washington [f] | 920,254 | 1.29 |
| 22 | West Virginia | 741,971 | 1.12 | 22 | Colorado | 869,328 | 1.22 |
| 23 | Washington [b] | 738,652 | 1.11 | 23 | Kansas | 860,579 | 1.21 |
| 24 | Colorado | 725,104 | 1.09 | 24 | Alabama | 828,847 | 1.17 |
| 25 | Michigan | 721,664 | 1.09 | 25 | Michigan | 813,336 | 1.14 |
| 26 | Alabama | 704,811 | 1.06 | 26 | Virginia [g] | 760,488 | 1.07 |
| 27 | Rhode Island | 623,490 | .94 | 27 | Rhode Island | 674,898 | .95 |
| 28 | Virginia | 606,343 | .91 | 28 | New Hampshire | 647,721 | .91 |
| 29 | Texas | 518,719 | .78 | 29 | Iowa | 564,124 | .79 |
| 30 | Iowa | 499,416 | .75 | 30 | Texas | 497,962 | .70 |
| 31 | Utah | 292,745 | .44 | 31 | New Mexico [h] | 381,011 | .54 |
| 32 | Montana | 292,549 | .44 | 32 | Utah | 338,382 | .48 |
| 33 | Nebraska | 283,280 | .43 | 33 | Nebraska | 324,239 | .46 |
| 34 | South Carolina | 247,998 | .37 | 34 | Arkansas | 315,478 | .44 |
| 35 | Arkansas | 240,350 | .36 | 35 | Oklahoma | 274,326 | .39 |
| 36 | Oklahoma | 186,454 | .28 | 36 | Montana | 265,956 | .37 |
| 37 | New Mexico | 168,567 | .25 | 37 | Arizona | 237,110 | .33 |
| 38 | South Dakota | 156,366 | .24 | 38 | Delaware | 158,192 | .22 |
| 39 | Delaware | 146,346 | .22 | 39 | South Dakota | 155,875 | .22 |
| 40 | Oregon | 92,391 | .13 | 40 | South Carolina | 129,377 | .18 |
| 41 | Wyoming | 80,098 | .12 | 41 | Oregon | 127,279 | .18 |
| 42 | Arizona | 65,231 | .10 | 42 | Idaho [i] | 65,843 | .27 |
| 43 | Indian Territory | 45,237 | .15 | 43 | Wyoming | 51,262 | |
| 44 | Idaho | 24,969 | | 44 | Alaska | 38,110 | |
| 45 | Hawaii | 23,346 | | 45 | Hawaii | 19,599 | |
| 46 | Nevada | 5,000 | | 46 | Florida | 15,000 | |
| 47 | Florida | 1,450 | | 47 | North Dakota | 3,260 | |
| 48 | North Dakota | 44 | | | | | |
| | Total | 66,378,794 | 100.00 | | Total | 71,105,805 | 100.00 |

[a] Includes a small output of sandstone from Connecticut.
[b] Includes Alaska marble.
[c] Includes a small value of sandstone for Connecticut.
[d] Includes a small value of sandstone for Virginia.
[e] Exclusive of a small value for sandstone included with New York.
[f] Exclusive of a small value for marble included with New Mexico.
[g] Exclusive of a small value for sandstone included with West Virgin
[h] Includes small values of marble for Idaho and Washington.
[i] Exclusive of a small value of marble included with New Mexico.

From this table it will be seen that the four ranking States in the production of stone in the United States did not change their relative position in regard to the value of stone quarried, although the percentage of output of the first two, Pennsylvania and Vermont, decreased somewhat, while New York and Ohio, coming next, increased in percentage of output. Massachusetts went from fifth to seventh place and Maine from eighth place to eleventh. These States produce large quantities of building granite, and the decrease was on account of the falling off in demand for this material. Illinois advanced from seventh place to fifth with a large increase in crushed stone output; Indiana remained in sixth place, although with decreased output. California, Wisconsin, and Missouri, with increased values, took eighth, ninth, and tenth places, respectively. Each of the above-mentioned States produced an output valued at over $2,000,000, while Georgia, Minnesota, New Jersey, Maryland, Tennessee, West Virginia, Connecticut, and Kentucky, in order of rank, each produced stone valued at more than $1,000,000.

The rank of States in the production of stone is influenced, especially in the States having small productions, by spasmodic demands for stone for special work—demands lasting perhaps two or three years and then followed by the abandonment of the quarry, which was possibly opened or reopened for this work. This applies especially to the building of dams, locks, and breakwaters, to the ballasting of railroads and the building of roads, to contracts for large buildings given to special quarries, to the running or closing down of iron furnaces which obtain their flux from local deposits, and to other local conditions. On the other hand, the demand upon well-known and regularly operated deposits, which receive orders for stone to be shipped all over the country, is influenced more by general conditions, particularly by the financial state of the market. The use of stone is rather a luxury than a necessity. There are other and cheaper building materials, although none perhaps so satisfactory as regards either durability or finished appearance. The prevailing taste or fashion for the variety or the color of the stone also influences sectional demand, which is at present largely confined to the light-colored stones for both building and monumental work. Hence the large amount of building and monumental work in white marbles and the use of light granites and of the light-colored limestones and light sandstones, and the consequent lack of demand for other darker stones which are equally good and durable.

The following table is given to show the total values of the stone used for various purposes in 1906 and 1907. Only those values are given which are for uses common to two or more varieties of stone:

*Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1906 and 1907.*

1906.

| Kind. | Building (rough and dressed). | Monumental (rough and dressed). | Flagstone. | Curbstone. | Paving stone. | Crushed stone. |
|---|---|---|---|---|---|---|
| Granite | $8,430,022 | $4,115,665 | $50,609 | $785,995 | $1,459,915 | $2,162,464 |
| Trap rock | 94,683 | | | | 193,012 | 3,341,863 |
| Sandstone | 4,275,669 | | 1,097,438 | 1,074,369 | 694,995 | 889,894 |
| Limestone | 5,098,631 | | 109,632 | 289,615 | 531,275 | 11,073,265 |
| Marble | 2,782,620 | 2,657,813 | | | | |
| Total | 20,681,625 | 6,773,478 | 1,257,679 | 2,149,979 | 2,879,197 | 17,467,486 |

*Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1906 and 1907*—Continued.

1907.

| Kind. | Building (rough and dressed). | Monumental (rough and dressed). | Flagstone. | Curbstone. | Paving stone. | Crushed stone. |
|---|---|---|---|---|---|---|
| Granite | $6,033,362 | $4,338,819 | $69,854 | $819,621 | $1,928,308 | $3,110,762 |
| Trap rock | 48,203 | .............. | .............. | .............. | 182,490 | 4,280,554 |
| Sandstone | 3,154,783 | .............. | 1,185,879 | 1,380,516 | 884,843 | 987,528 |
| Limestone | 4,580,226 | .............. | 84,076 | 378,853 | 545,300 | 13,675,453 |
| Marble | 2,859,237 | 2,640,130 | .............. | .............. | .............. | .............. |
| Total | 16,675,811 | 6,978,949 | 1,339,809 | 2,578,990 | 3,540,941 | 22,054,297 |

This table shows that the total value of building stone decreased from $20,681,625 in 1906 to $16,675,811 in 1907, a loss of $4,005,814. In 1907 granite represented 36.18 per cent of this building stone, limestone 27.47 per cent, sandstone 18.92 per cent, and marble 17.15 per cent.

Monumental stone increased in value from $6,773,478 in 1906 to $6,978,949 in 1907, a gain of $205,471. Of the monumental stone, 62.17 per cent was granite in 1907 and 37.83 per cent marble. Small quantities of sandstone and limestone used for monuments and bases for monuments are not given separately, but are included under stone used for "Other purposes."

Flagstone increased in value $82,130, or from $1,257,679 in 1906 to $1,339,809 in 1907. Sandstone represented 88.51 per cent of the flagstone output in 1906, the quantity of granite and limestone used for this purpose being very small. Of the sandstone used as flagstone over one-half was the bluestone of New York and Pennsylvania.

Curbstone increased in value from $2,149,979 in 1906 to $2,578,990 in 1907, or $429,011. Sandstone represented 53.53 per cent of this output in 1906, granite 31.78 per cent, and limestone 14.69 per cent.

Paving stone increased in value from $2,879,197 in 1906 to $3,540,941 in 1907, a gain of $661,744. Granite represented 54.46 per cent of the total paving material, sandstone 24.99 per cent, limestone 15.40 per cent, and trap rock 5.15 per cent.

Crushed stone increased in value from $17,467,486 in 1906 to $22,054,297 in 1907, or $4,586,811. Limestone represented 62.01 per cent of the output, trap rock 19.41 per cent, granite 14.10 per cent, and sandstone 4.48 per cent.

Notwithstanding the fact that the financial and trade conditions during the last half of 1907 caused a break in building operations and so materially affected the output of building stone that it decreased in value $4,005,814, there was a decided increase of $4,727,011 in the total value of the stone output, the principal increase being in the value of crushed stone, which gained $4,586,811 in 1907 as compared with 1906. Building stone, however, has been affected not only by the financial depression, but by the use of concrete, in which large quantities of crushed stone are consumed; also heavy building stone for foundations and for the construction of walls, bridges, etc., has been to some extent replaced by concrete. Thus the loss in one branch of the stone industry has helped to keep up the demand in another.

The crushed-stone industry has shown a remarkable increase in the past decade. The demand for this kind of stone was first established by the demand for good roads, especially in the New England and the Middle Atlantic States, and the industry has steadily grown, developing various different uses for this stone as well as increasing in quantity and value. In 1897 the crushed stone reported was chiefly trap rock from New York and New Jersey, some granite, and a small quantity of limestone. The value of crushed granite and trap rock at that time did not equal $1,000,000, and the limestone was not reported separately from stone sold for building purposes. The crushed stone was all reported as used for road making, but probably included some stone sold for railroad ballast. In 1898 the crushed-stone output, including trap rock, granite, and limestone, was valued at $4,031,445, and the increase has been steady, although not regular, ever since, reaching the highest value in 1907 and showing an increase over 1898 of $18,022,852. This makes the value for 1907 5.47 times as large as that for 1898. The price per ton has also increased slightly in the last three or four years, the average selling price in the ten years ranging from about 45 cents per ton to 63 cents per ton.

The irregularity of the building-stone production as compared with the steady and more regular increase in crushed stone is of such interest in showing the condition of these two branches of the stone industry that the following table has been made, which gives the values of these two products for the last ten years. The figures for 1898 are incomplete in that they do not include the value of sandstone used for building purposes, nor do they include some stone sold rough for building purposes.

*Value of building stone and of crushed stone, 1898–1907.*

| Year. | Building stone (rough and dressed). | Crushed stone. | Year. | Building stone (rough and dressed). | Crushed stone. |
|---|---|---|---|---|---|
| 1898 | [a] $5,122,511 | [b] $4,031,445 | 1903 | $19,795,491 | $13,188,938 |
| 1899 | [c] 10,741,927 | 4,692,343 | 1904 | 18,883,455 | 15,530,122 |
| 1900 | 10,672,598 | 6,525,368 | 1905 | 20,240,809 | 16,419,614 |
| 1901 | 15,112,600 | 8,560,432 | 1906 | 20,681,625 | 17,467,486 |
| 1902 | 20,790,341 | 11,480,959 | 1907 | 16,675,811 | 22,054,297 |

[a] Does not include stone sold rough for building or sandstone used for building.
[b] Includes limestone used for paving.
[c] Does not include stone sold rough for building.

The following tables show the quantity and value of crushed stone produced in the United States in 1906 and 1907, by States and Territories, and uses:

*Production of crushed stone in 1906 and 1907, by States and Territories and uses, in short tons.*

### 1906.

| State or Territory. | Road making. | | Railroad ballast. | | Concrete. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 17,040 | $9,380 | .......... | .......... | 10,192 | $7,280 | 27,232 | $16,660 |
| Arizona | .......... | .......... | .......... | .......... | .......... | .......... | 0 | 0 |
| Arkansas | 27,390 | 22,577 | 30,000 | $26,000 | 63,059 | 61,264 | 120,449 | 109,841 |
| California | 396,029 | 327,457 | 65,031 | 34,904 | 651,590 | 453,648 | 1,112,650 | 816,009 |
| Colorado | 7,210 | 3,832 | 22,000 | 7,600 | 49,697 | 26,139 | 78,907 | 37,571 |
| Connecticut | 387,288 | 231,001 | 47,803 | 20,750 | 280,731 | 152,448 | 715,822 | 404,199 |
| Delaware | 10,299 | 6,814 | 56,839 | 37,129 | 74,928 | 48,849 | 142,066 | 92,792 |
| Florida | .......... | .......... | .......... | .......... | 250 | 100 | 250 | 100 |
| Georgia | 23,862 | 19,400 | 290,450 | 151,365 | 107,700 | 82,450 | 422,012 | 253,215 |
| Hawaii | 2,796 | 4,476 | 300 | 150 | 9,184 | 6,645 | 12,280 | 11,271 |
| Illinois | 1,235,186 | 686,292 | 737,028 | 389,065 | 1,090,679 | 709,907 | 3,062,893 | 1,785,264 |
| Indiana | 658,727 | 321,891 | 477,737 | 169,695 | 243,834 | 119,222 | 1,380,298 | 610,808 |
| Indian Territory | .......... | .......... | 50,000 | 20,000 | 50,000 | 20,000 | 100,000 | 40,000 |
| Iowa | 59,362 | 38,339 | 60,803 | 26,268 | 251,686 | 142,124 | 371,851 | 206,731 |
| Kansas | 62,952 | 39,877 | 1,119,416 | 533,173 | 50,034 | 34,228 | 1,232,402 | 607,278 |
| Kentucky | 332,137 | 222,877 | 578,502 | 250,237 | 79,508 | 50,827 | 990,147 | 523,941 |
| Maine | 14,580 | 9,931 | .......... | .......... | 17,045 | 11,504 | 31,625 | 21,435 |
| Maryland | 168,191 | 156,245 | 197,126 | 116,306 | 171,944 | 190,993 | 537,261 | 463,544 |
| Massachusetts | 504,289 | 390,517 | 69,930 | 28,000 | 398,787 | 329,174 | 973,006 | 747,691 |
| Michigan | 145,155 | 78,437 | 206,375 | 103,442 | 94,536 | 61,852 | 446,066 | 243,731 |
| Minnesota | 138,380 | 102,246 | 31,509 | 24,741 | 241,563 | 190,027 | 411,452 | 317,014 |
| Missouri | 360,785 | 294,511 | 671,803 | 336,752 | 524,969 | 379,994 | 1,557,557 | 1,011,257 |
| Montana | 4,555 | 6,000 | .......... | .......... | .......... | .......... | 4,555 | 6,000 |
| Nebraska | 20,000 | 16,000 | 49,968 | 29,980 | 135,462 | 112,253 | 205,430 | 158,233 |
| New Hampshire | 14,200 | 10,350 | 1,770 | 426 | 13,660 | 9,918 | 29,630 | 20,694 |
| New Jersey | 604,010 | 451,174 | 260,044 | 147,191 | 400,804 | 259,964 | 1,264,858 | 858,329 |
| New Mexico | .......... | .......... | 350,167 | 139,217 | 12,500 | 6,000 | 362,667 | 145,217 |
| New York | 1,307,524 | 844,226 | 771,106 | 369,940 | 1,276,893 | 734,055 | 3,355,523 | 1,948,221 |
| North Carolina | 51,972 | 49,274 | 299,391 | 134,800 | 79,964 | 60,762 | 431,327 | 244,836 |
| Ohio | 1,728,163 | 931,146 | 951,888 | 426,305 | 632,942 | 300,035 | 3,312,993 | 1,657,486 |
| Oklahoma | 12,700 | 9,050 | 157,500 | 90,000 | 15,600 | 10,175 | 185,800 | 109,225 |
| Oregon | 59,247 | 34,223 | 15,918 | 7,111 | 17,175 | 8,342 | 92,340 | 49,676 |
| Pennsylvania | 822,774 | 517,751 | 1,757,718 | 1,000,044 | 1,221,162 | 782,640 | 3,801,654 | 2,300,435 |
| Rhode Island | 53,112 | 41,018 | .......... | .......... | 3,150 | 3,765 | 56,262 | 44 783 |
| South Carolina | 9,320 | 6,825 | 24,111 | 11,796 | 78,007 | 56,896 | 111,438 | 75,517 |
| South Dakota | 225 | 180 | 300 | 157 | 23,940 | 24,000 | 24,465 | 24,337 |
| Tennessee | 43,175 | 23,725 | 420,083 | 192,614 | 115,657 | 75,063 | 578,915 | 291,402 |
| Texas | 28,600 | 19,450 | 59,872 | 26,067 | 125,881 | 67,829 | 214,353 | 113,346 |
| Utah | 13,100 | 13,030 | .......... | .......... | 20 | 15 | 13,120 | 13,045 |
| Vermont | 5,284 | 4,045 | 2,402 | 1,100 | 2,840 | 2,472 | 10,526 | 7,617 |
| Virginia | 31,308 | 35,141 | 159,490 | 80,436 | 118,553 | 107,377 | 309,351 | 222,954 |
| Washington | 15,640 | 13,262 | 12,250 | 9,500 | 6,203 | 4,963 | 34,093 | 27,725 |
| West Virginia | 38,507 | 21,140 | 145,525 | 71,260 | 55,982 | 32,980 | 240,014 | 125,380 |
| Wisconsin | 596,476 | 363,214 | 181,067 | 86,575 | 392,605 | 250,870 | 1,170,148 | 700,650 |
| Wyoming | .......... | .......... | 1,800 | 810 | 2,364 | 1,207 | 4,164 | 2,017 |
| Total | 10,011,550 | 6,376,324 | 10,335,022 | 5,100,906 | 9,193,280 | 5,990,256 | 29,539,852 | 17,467,486 |

*Production of crushed stone in 1906 and 1907, by States and Territories and uses, in short tons*—Continued.

1907.

| State or Territory. | Road making. |  | Railroad ballast. |  | Concrete. |  | Total. |  |
|---|---|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 10,000 | $5,000 | .......... | .......... | 45,164 | $21,287 | 55,164 | $26,287 |
| Arizona | .......... | .......... | .......... | .......... | 25,062 | 41,645 | 25,062 | 41,645 |
| Arkansas | 6,537 | 6,983 | 5,000 | $5,000 | 164,956 | 179,617 | 176,493 | 191,600 |
| California | 849,869 | 629,114 | 265,038 | 96,214 | 525,938 | 479,592 | 1,640,845 | 1,204,920 |
| Colorado | 1,000 | 900 | 23,978 | 21,580 | 41,342 | 20,715 | 66,320 | 43,195 |
| Connecticut | 393,842 | 222,206 | 149,321 | 74,660 | 283,110 | 148,435 | 826,273 | 445,301 |
| Delaware | 60,535 | 40,298 | 58,153 | 36,668 | 51,610 | 41,628 | 170,298 | 118,594 |
| Florida | 6,000 | 15,000 | .......... | .......... | .......... | .......... | 6,000 | 15,000 |
| Georgia | 39,027 | 25,407 | 310,969 | 152,847 | 82,078 | 61,051 | 432,074 | 239,305 |
| Hawaii | .......... | .......... | .......... | .......... | 9,850 | 7,599 | 9,850 | 7,599 |
| Idaho | 11,631 | 17,392 | .......... | .......... | .......... | .......... | 11,631 | 17,392 |
| Illinois | 1,517,425 | 958,032 | 788,894 | 499,204 | 1,576,256 | 1,118,919 | 3,882,575 | 2,576,155 |
| Indiana | 972,695 | 476,711 | 323,650 | 134,932 | 120,289 | 60,918 | 1,416,634 | 672,561 |
| Iowa | 101,696 | 69,817 | 158,651 | 77,571 | 186,636 | 118,682 | 446,983 | 266,070 |
| Kansas | 87,208 | 76,420 | 733,511 | 357,820 | 122,903 | 55,469 | 943,622 | 489,709 |
| Kentucky | 417,823 | 292,241 | 691,405 | 292,714 | 76,718 | 54,917 | 1,185,946 | 639,872 |
| Maine | 1,688 | 1,511 | 750 | 325 | 33,437 | 19,926 | 35,875 | 21,762 |
| Maryland | 366,910 | 348,875 | 164,800 | 103,147 | 429,598 | 499,337 | 961,308 | 951,359 |
| Massachusetts | 423,905 | 315,221 | 85,920 | 42,860 | 394,005 | 326,864 | 903,830 | 684,945 |
| Michigan | 225,522 | 131,708 | 90,279 | 46,516 | 191,167 | 97,762 | 506,968 | 275,986 |
| Minnesota | 183,021 | 156,026 | 42,592 | 36,398 | 182,224 | 153,937 | 407,837 | 346,361 |
| Missouri | 673,659 | 444,685 | 532,050 | 284,158 | 549,972 | 454,433 | 1,755,681 | 1,183,276 |
| Nebraska | 63,221 | 55,824 | 65,148 | 53,584 | 145,757 | 121,027 | 274,126 | 230,435 |
| New Hampshire | 5,300 | 3,975 | .......... | .......... | 21,887 | 14,349 | 27,187 | 18,324 |
| New Jersey | 735,681 | 578,640 | 323,682 | 210,247 | 304,168 | 235,129 | 1,363,531 | 1,024,016 |
| New Mexico | 375 | 300 | 783,961 | 342,546 | .......... | .......... | 784,336 | 342,846 |
| New York | 2,500,143 | 1,827,416 | 958,506 | 466,890 | 956,080 | 601,605 | 4,414,729 | 2,895,911 |
| North Carolina | 97,907 | 62,939 | 364,369 | 175,847 | 145,014 | 106,497 | 601,290 | 345,283 |
| Ohio | 2,367,125 | 1,245,296 | 975,735 | 414,653 | 666,757 | 306,277 | 4,009,617 | 1,966,226 |
| Oklahoma | 4,600 | 4,000 | 243,137 | 146,747 | 26,335 | 16,405 | 274,072 | 167,152 |
| Oregon | 101,484 | 80,205 | 5,888 | 1,744 | 5,110 | 7,450 | 112,482 | 89,399 |
| Pennsylvania | 1,236,037 | 785,445 | 1,701,152 | 1,075,160 | 1,136,540 | 693,354 | 4,073,729 | 2,553,959 |
| Rhode Island | 22,040 | 25,480 | .......... | .......... | 5,500 | 5,550 | 27,540 | 31,030 |
| South Carolina | 26,097 | 25,887 | 10 | 17 | 6,250 | 4,500 | 32,357 | 30,404 |
| South Dakota | 28,000 | 14,000 | .......... | .......... | 10,500 | 10,500 | 38,500 | 24,500 |
| Tennessee | 26,250 | 13,994 | 270,923 | 118,911 | 69,498 | 41,530 | 366,671 | 174,435 |
| Texas | 103,915 | 64,318 | 171,927 | 79,843 | 47,267 | 48,858 | 323,109 | 193,019 |
| Vermont | 8,558 | 7,688 | .......... | .......... | 4,050 | 4,850 | 12,608 | 12,538 |
| Virginia | 126,775 | 96,937 | 138,221 | 63,073 | 214,021 | 200,286 | 479,017 | 360,296 |
| Washington | 10,550 | 17,930 | 1,000 | 500 | .......... | .......... | 11,550 | 18,430 |
| West Virginia | 36,048 | 18,406 | 573,454 | 272,887 | 70,565 | 49,012 | 680,067 | 340,305 |
| Wisconsin | 763,383 | 506,957 | 73,006 | 36,026 | 417,405 | 233,477 | 1,253,794 | 776,460 |
| Wyoming | 100 | 60 | .......... | .......... | 450 | 375 | 550 | 435 |
| Total | 14,607,582 | 9,669,244 | 11,075,080 | 5,721,289 | 9,345,469 | 6,663,764 | 35,028,131 | 22,054,297 |

From this table it will be seen that New York, producing 13.14 per cent; Illinois, 11.68 per cent; Pennsylvania, 11.58 per cent; Ohio, 8.92 per cent; California, 5.46 per cent; Missouri, 5.37 per cent; and New Jersey, 4.64 per cent of the total crushed stone output of the United States, were the principal crushed-stone producing States in 1907. Each of these had an output valued at more than $1,000,000.

The following table shows the quantity and value of crushed stone produced in the United States in 1906 and 1907, by uses and kinds of stone:

*Quantity and value of crushed stone produced in the United States in 1906 and 1907, by kinds and uses, in short tons.*

1906.

| Kind. | Road making. | | Railroad ballast. | | Concrete. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Granite | 858,289 | $722,807 | 1,066,784 | $545,771 | 1,016,494 | $893,886 | 2,941,567 | $2,162,464 |
| Trap rock | 2,109,404 | 1,496,140 | 799,094 | 477,022 | 2,145,690 | 1,368,701 | 5,054,188 | 3,341,863 |
| Limestone | 6,685,781 | 3,857,500 | 8,106,850 | 3,899,396 | 5,493,958 | 3,316,369 | 20,286,589 | 11,073,265 |
| Sandstone | 358,076 | 209,877 | 362,294 | 178,717 | 537,138 | 411,300 | 1,257,508 | 889,894 |
| Total | 10,011,550 | 6,376,324 | 10,335,022 | 5,100,906 | 9,193,280 | 5,990,256 | 29,539,852 | 17,467,486 |
| Average price | | .64 | | .49 | | .65 | | .59 |

1907.

| Kind. | Road making. | | Railroad ballast. | | Concrete. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Granite | 1,262,069 | $1,060,658 | 1,447,406 | $714,574 | 1,375,973 | $1,335,530 | 4,085,448 | $3,110,762 |
| Trap rock | 3,265,249 | 2,435,152 | 1,181,260 | 680,897 | 1,626,963 | 1,164,505 | 6,073,472 | 4,280,554 |
| Limestone | 9,619,178 | 5,860,977 | 8,122,342 | 4,144,345 | 5,791,377 | 3,670,131 | 23,532,897 | 13,675,453 |
| Sandstone | 461,086 | 312,457 | 324,072 | 181,473 | 551,156 | 493,598 | 1,336,314 | 987,528 |
| Total | 14,607,582 | 9,669,244 | 11,075,080 | 5,721,289 | 9,345,469 | 6,663,764 | 35,028,131 | 22,054,297 |
| Average price | | .66 | | .52 | | .71 | | .63 |

From this table it appears that the production of crushed stone increased decidedly in 1907, the output amounting to 35,028,131 short tons, valued at $22,054,297, as compared with 29,539,852 short tons, valued at $17,467,486, in 1906—an increase in quantity of 5,488,279 short tons, and in value of $4,586,811. The total average price per ton increased from 59 cents in 1906 to 63 cents in 1907.

Crushed granite increased from 2,941,567 short tons, valued at $2,162,464, in 1906, to 4,085,448 short tons, valued at $3,110,762, in 1907, a gain of 1,143,881 tons in quantity and of $948,298 in value. The average value per ton increased from 74 cents in 1906 to 76 cents in 1907.

Crushed trap rock increased from 5,054,188 short tons, valued at $3,341,863, in 1906, to 6,073,472 short tons, valued at $4,280,544, in 1907, a gain of 1,019,284 short tons in quantity and of $938,691 in value. The average price per ton was 70 cents in 1907, and 66 cents in 1906.

Crushed limestone increased from 20,286,589 short tons, valued at $11,073,265, in 1906, to 23,532,897 short tons, valued at $13,675,453, in 1907, a gain of 3,246,308 short tons in quantity and of $2,602,188 in value. The average price per ton increased from 55 cents in 1906 to 58 cents in 1907.

Crushed sandstone increased from 1,257,508 short tons, valued at $889,894, in 1906, to 1,336,314 short tons, valued at $987,528, in 1907, a gain of 78,806 short tons in quantity and of $97,634 in value. The average price per ton was 71 cents in 1906 and 74 cents in 1907.

In tabulating the figures for crushed stone according to the uses which this stone served, it is very probable that some of the stone reported as sold for road making was in fact used for concrete, as in many cases large dealers report that they do not know the exact purpose to which the stone sold by them is to be applied, and the division is in many cases approximated.

Crushed stone for road making increased from 10,011,550 short tons, valued at $6,376,324, in 1906, to 14,607,582 short tons, valued at $9,669,244, in 1907, a gain of 4,596,032 tons, valued at $3,292,920. It is particularly noteworthy that the greatest increase in the crushed-stone production was in the stone sold for road making. The average price per ton was 64 cents in 1906 and 66 cents in 1907.

Crushed stone for railroad ballast increased from 10,335,022 short tons, valued at $5,100,906, in 1906, to 11,075,080 short tons, valued at $5,721,289, in 1907, a gain of 740,058 short tons in quantity and of $620,383 in value. The average price per ton was 49 cents in 1906 and 52 cents in 1907.

Crushed stone for concrete increased from 9,193,280 short tons, valued at $5,990,256, in 1906, to 9,345,469 short tons, valued at $6,663,744, in 1907, a gain of 152,189 short tons in quantity and of $673,508 in value, a very large increase in value compared with the increase in output. The avarage value increased from 65 cents per ton in 1906 to 71 cents per ton in 1907.

An increase in the price of crushed stone was reported by almost all of the producers, the reason assigned being the cost of labor and of supplies.

## EXPORTS AND IMPORTS.

The following figures, compiled from statistics furnished by the Bureau of Statistics of the Department of Commerce and Labor, give the value of the exports and imports of stone for the calendar years 1906 and 1907:

*Exports of stone from the United States in 1906 and 1907.*

| Kind. | 1906. | 1907. |
|---|---|---|
| Marble and stone, unmanufactured | $355,343 | $407,193 |
| All others | 780,539 | 681,798 |
| Total | 1,135,882 | 1,088,991 |

*Imports of stone into the United States in 1906 and 1907.*

| Kind. | 1906. | 1907. | Kind. | 1906. | 1907. |
|---|---|---|---|---|---|
| Marble: | | | Granite: | | |
| In block, rough, etc | $892,717 | $1,040,333 | Dressed | $145,144 | $166,524 |
| Sawed or dressed | 306 | 1,132 | Rough | 20,931 | 8,779 |
| Slabs or paving tiles | 93,760 | 50,718 | | | |
| All other manufactures | 220,150 | 257,456 | Total | 166,075 | 175,303 |
| Mosaic cubes | 48,183 | 49,893 | Stone (other): | | |
| | | | Dressed | 16,354 | 26,003 |
| Total | 1,255,116 | 1,399,532 | Rough | 41,255 | 38,761 |
| Onyx: | | | Total | 57,609 | 64,764 |
| In block, rough, etc | 76,385 | 57,795 | | | |
| All other manufactures | 1,482 | 7,678 | Grand total | 1,556,667 | 1,705,072 |
| Total | 77,867 | 65,473 | | | |

These tables show that the stone exported decreased in value from $1,135,882 in 1906 to $1,088,991 in 1907, a loss of $46,891.

The value of the stone imported increased from $1,556,667 in 1906 to $1,705,072 in 1907, a gain of $148,405.

## GRANITE.

*Total production.*—The figures given in this report as representing the value of the granite production in the United States include and the value of small quantities of gneiss, mica schist, lava, tuff, trachyte, andesite, syenite, quartz porphyry, trap, basalt, and allied igneous rocks. The quantities of these allied stones quarried are too small to tabulate separately. Trap rock in the States of California, Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania, however, as already noted, represents an industry sufficient by itself to make it advisable to tabulate this stone separately, and its value is therefore not included in the grand total of granite, as has been done in previous years.

The value of the granite output in the United States, not including the trap rock, was $18,064,708; in 1906 this value was $18,562,806—a decrease in 1907 of $498,098. The increase in 1906 over the total for 1905, which was $17,563,139, was $999,667. In 1906, notwithstanding the large increase in output, the quarrymen, especially the small producers, reported a decrease of trade due to the use of cement and concrete in building, to high wages, to high price of supplies, and to scarcity of common labor. In 1907, in addition to these conditions, the unsettled financial situation during the latter part of the year hurt the building trade and affected the large producers, who depend on general trade, more than the small producers depending on local markets.

Granite for building stone decreased heavily in value of output; monumental stone increased slightly, as did stone sold for flagging and curbing, while stone sold for paving blocks, crushed stone, riprap, rubble, etc., increased considerably.

In 1906 the rank in output of States producing granite to the value of $500,000 or more was Massachusetts, Vermont, Maine, Connecticut, Maryland, New Hampshire, Wisconsin, Georgia, North Carolina, California, Minnesota, and Rhode Island; in 1907 the rank was Vermont, Massachusetts, Maine, California, Wisconsin, Maryland, North Carolina, Georgia, Rhode Island, New Hampshire, Connecticut, and Washington

California showed a large increase in output due to heavy demand and higher prices, contingent to the repair of the ravages made by the earthquake during the spring of 1906.

Connecticut, Maine, Massachusetts, Minnesota, New Hampshire, and Vermont decreased chiefly in the value of building stone; and Georgia, Maryland, North Carolina, Rhode Island, Washington, and Wisconsin showed increased output.

Arkansas, Colorado, Delaware, Idaho, New Mexico, Oklahoma, Oregon, Pennsylvania, South Dakota, Utah, and Virginia increased in output, and Arizona, Hawaii, Missouri, Montana, New Jersey, New York, South Carolina, Texas, and Wyoming decreased.

The output from Arizona, Colorado, Hawaii, Idaho, Oregon, Utah, and Wyoming includes considerable volcanic rock and tuff.

The production of a few of the other States (notably Maryland and Virginia) includes, besides these varieties of igneous rock, gneiss, trap, mica schist, syenite, andesite, diabase, etc., but only in small quantities as compared with the total production.

*Building stone.*—Building stone, including rough and dressed granite sold by producers, was valued at $6,033,362 in 1907, a decrease of $2,396,660 as compared with the total value of $8,430,022 in 1906. In 1906 the increase over 1905, when the total output was $7,243,219, was $1,186,803.

The rough building stone sold by the granite quarrymen was valued at $1,280,769 in 1907 and at $1,770,918 in 1906, a decrease of $490,149 in this class of material. Maine, Massachusetts, and Pennsylvania report the greatest values for the rough building stone sold, and while this value for Massachusetts increased somewhat in 1907, the value for the other States decreased. Connecticut also showed a decreased output of rough building stone.

The dressed stone sold for building by the quarrymen was valued at $4,752,593 in 1907 and at $6,659,104 in 1906, a decrease of $1,906,511. In 1906 Massachusetts reported $1,750,695 as the value of the dressed building stone sold, Vermont $1,422,862, and Maine $1,413,486; in 1907 these States reported values for this class of product as follows: Vermont $1,009,353, Maine $1,007,572, and Massachusetts $907,119—a decrease of $843,576 for Massachusetts, $413,509 for Vermont, and $405,914 for Maine. A large part of the decrease for Massachusetts was due to the cessation of the quarrying at Milford, Mass., of stone for the new Pennsylvania Railroad station in New York City. Most of the large producers of this class of material report decreased demand for building stone, especially for large foundation stone, due, as already stated, to the financial situation in 1907 and somewhat to the use of concrete for foundations. Although Vermont had the largest output of dressed building stone, Maine and Massachusetts both exceed Vermont in the total value of building stone, including both rough and dressed. The California figures for 1907 show, as compared with those for 1906, a notable increase in output of building stone due to local causes.

*Monumental stone.*—Monumental stone, including stone cut and dressed by the producers and also the rough stock sold by them, was valued at $4,338,819 in 1907, as against $4,115,665 in 1906, an increase of $223,154. Of the 1907 total, $2,239,327 was the value of rough stock and $2,099,492 the value of dressed stone sold by the producers. In 1906 the rough stock was valued at $2,293,144 and the dressed stone at $1,822,521, a decrease in 1907 of $53,817 in value of rough stock and an increase of $276,971 in value of finished stone.

Vermont produces more rough stock and sells more dressed stone than any other State. The output of this class of stone in Vermont in 1907 was valued at $1,637,922 and in 1906 at $1,444,442, an increase in 1907 of $193,480. Massachusetts ranks next to Vermont, with an output of $403,594 in 1907 and of $724,614 in 1906, a decrease in 1907 of $321,020. Other States prominent in output of monumental stone are Rhode Island, Minnesota, Maine, Wisconsin, New Hampshire, and Connecticut.

*Paving blocks.*—The paving-block industry increased in value from $1,459,915 in 1906 to $1,928,308 in 1907, a gain of $468,393. Wisconsin, Maine, and Massachusetts were the largest producers of this class of material.

*Curbstone.*—Granite curbing in 1907 was produced to the value of $819,621, against $785,995 in 1906, an increase of $33,626 for 1907.

Georgia, Maine, and California had the largest curbstone output in 1907.

*Flagstone.*—The value of this class of product increased from $50,609 in 1907 to $69,854 in 1906, a gain of $19,245. Maine and Maryland were the largest producers in 1907.

*Rubble.*—Granite reported as used for rubble was valued at $717,998 in 1907, as against $360,763 in 1906, an increase of $357,235 in 1907. California, Connecticut, and Massachusetts showed large gains in value of rubble.

*Riprap.*—Granite sold for riprap increased in value from $322,022 in 1906 to $620,033 in 1907, a gain of $298,011. Washington and Connecticut had the largest values in 1907.

*Crushed stone.*—Granite crushed and sold for the purpose of road building, as railroad ballast, and as concrete for buildings, pavements, etc., was valued at $3,110,762 in 1907, as against $2,162,464 in 1906, an increase of $948,298 in 1907. These figures represent an output of 4,085,448 short tons in 1907 and of 2,941,567 short tons in 1906, an increase in 1907 of 1,143,881 tons. Of the total 1907 output, 1,262,069 tons, valued at $1,060,658, was for road making; 1,447,406 tons, valued at $714,574, for railroad ballast, and 1,375,973 tons, valued at $1,335,530, for concrete. These figures for 1906 were as follows: 858,289 tons, valued at $722,807, for road making; 1,066,784 tons, valued at $545,771, for railroad ballast; and 1,016,494 tons, valued at $893,886, for concrete, an increase in 1907 of 403,780 tons in quantity and $337,851 in value for road making; of 380,622 tons in quantity and $168,803 in value for railroad ballast, and of 359,479 tons in quantity and $441,644 in value for concrete. The total average price per ton was 74 cents in 1906 and 76 cents in 1907. The average price per ton for road making was 84 cents in 1907 and 84 cents in 1906; for railroad ballast it was 49 cents in 1907 and 51 cents in 1906; for concrete 97 cents in 1907 and 88 cents in 1906. Maryland, North Carolina, Virginia, and Georgia had the largest values for crushed granite in 1907, Maryland reporting the greatest value for road making, North Carolina for railroad ballast, and Maryland for concrete. The output of Maryland includes some trap rock and gneiss; the output of Virginia includes gneiss.

The table following shows the value of the granite, including small values for trap and other igneous rocks, produced in the United States in 1906 and 1907, by States and Territories, and by uses in 1906 and 1907.

*Value of granite and other igneous rocks produced in the United States in 1906 and 1907, by States and Territories and uses.*

## 1906.

| State or Territory. | Sold in the rough. | | | Dressed for building. | Dressed for monumental work. | Made into paving blocks. | Curbing. | Flagging. |
|---|---|---|---|---|---|---|---|---|
| | Building. | Monumental. | Other. | | | | | |
| Arizona | $7,800 | $3,000 | $21,042 | | | | $50 | |
| Arkansas | 1,000 | 500 | 100 | | | | 11,250 | |
| California | 21,489 | 50,541 | 119,057 | $255,189 | $34,285 | $61,115 | 64,975 | |
| Colorado | 13,450 | 28,508 | | | 18,000 | | 4,000 | |
| Connecticut | 158,189 | 44,433 | 13,880 | 428,915 | 64,019 | 62,805 | 19,064 | $2,235 |
| Delaware | 9,997 | | | 7,629 | | 7,783 | 7,509 | 734 |
| Georgia | 109,215 | 56,010 | 400 | 26,350 | | 123,211 | 189,524 | 750 |
| Hawaii | | | | | | | | |
| Idaho | 400 | | | | | | | |
| Maine | 349,668 | 78,802 | 54,179 | 1,413,486 | 192,577 | 336,979 | 66,786 | 5,299 |
| Maryland | 211,524 | 80,780 | 9,430 | 113,093 | 1,730 | 51,539 | 27,745 | 3,788 |
| Massachusetts | 220,121 | 435,280 | 117,847 | 1,750,695 | 289,334 | 199,457 | 89,469 | 4,080 |
| Minnesota | 23,686 | 100,086 | 1,300 | 141,171 | 189,319 | 50,000 | 13,587 | 1,850 |
| Missouri | 199 | 28,475 | | 25,800 | | 26,295 | 1,375 | |
| Montana | 51,020 | 500 | | 18,700 | 13,210 | | 13,500 | |
| New Hampshire | 90,751 | 91,044 | 2,337 | 342,336 | 98,622 | 89,878 | 52,939 | 9,690 |
| New Jersey | 21,019 | 730 | 500 | 25,795 | | 1,216 | | |
| New York | 19,729 | 623 | 100,750 | 162,766 | 4,368 | | 227 | |
| North Carolina | 62,059 | 17,477 | 748 | 289,705 | 5,733 | 33,428 | 124,499 | 3,762 |
| Oklahoma | 350 | 4,070 | 100 | 9,500 | | 113 | 600 | 640 |
| Oregon | 5,848 | 200 | 24 | | | | 673 | |
| Pennsylvania | 207,451 | 3,525 | 13,808 | 20,052 | | 19,318 | 3,375 | 74 |
| Rhode Island | 10,310 | 150,525 | 1,387 | 184,614 | 171,700 | 42,532 | 3,500 | 600 |
| South Carolina | 26,910 | 35,690 | 25,507 | 8,564 | | 11,340 | 45,605 | 10,700 |
| Texas | 12,665 | 20,961 | 48,349 | 1,400 | 44,500 | 250 | 500 | |
| Utah | 1,273 | 3,500 | 9 | | | | | 116 |
| Vermont | 47,154 | 993,220 | 151 | 1,422,862 | 451,222 | 9,557 | 6,818 | |
| Virginia | 18,158 | 15,804 | 200 | | 16,936 | 29,536 | 14,339 | 1,216 |
| Washington | 68,363 | 16,196 | 252,068 | 8,447 | 366 | 16,240 | 20,980 | |
| Wisconsin | 520 | 23,664 | | 1,435 | 226,600 | 287,823 | 3,106 | 5,073 |
| Wyoming | 600 | | | | | | | |
| Total | 1,770,918 | 2,293,144 | 792,173 | 6,659,104 | 1,822,521 | 1,459,915 | 785,995 | 50,609 |

| State or Territory. | Rubble. | Riprap. | Crushed stone. | | | Other. | Total. |
|---|---|---|---|---|---|---|---|
| | | | Road making. | Railroad ballast. | Concrete. | | |
| Arizona | $150 | | | | | | $32,042 |
| Arkansas | 8,191 | $15,000 | $20,000 | $25,000 | $37,862 | | 118,903 |
| California | 12,121 | 33,819 | 47,028 | 24,800 | 16,365 | | 740,784 |
| Colorado | | | 332 | | 1,112 | | 65,402 |
| Connecticut | 6,081 | 168,206 | 2,648 | | 4,000 | $40 | 974,024 |
| Delaware | 3,962 | 15,940 | 6,814 | 37,129 | 48,849 | | 146,346 |
| Georgia | 27,515 | 7,000 | 19,400 | 150,600 | 81,400 | 850 | 792,315 |
| Hawaii | | | 4,476 | 150 | 6,645 | 12,075 | 23,346 |
| Idaho | | | | | | | 400 |
| Maine | 18,243 | 1,875 | 9,931 | | 11,504 | 20,692 | 2,560,021 |
| Maryland | 52,563 | 4,290 | 125,655 | 5,803 | 171,869 | 23,472 | 883,851 |
| Massachusetts | 61,367 | 3,107 | 70,897 | | 84,946 | 816 | 3,327,416 |
| Minnesota | 19,553 | 660 | 31,397 | 16,700 | 34,930 | 1,810 | 626,069 |
| Missouri | 150 | 3,557 | 300 | | 63,858 | | 150,009 |
| Montana | 11,075 | | 6,000 | | | | 114,005 |
| New Hampshire | 15,167 | 2,323 | 10,350 | 426 | 9,918 | 2,350 | 818,131 |
| New Jersey | | 33 | 5,000 | 46,313 | 300 | 318 | 101,224 |
| New York | 323 | 112 | 3,150 | | 3,000 | | 304,048 |
| North Carolina | 5,688 | 4,140 | 18,601 | 134,800 | 60,762 | 17,355 | 778,847 |
| Oklahoma | 500 | 2,505 | | | 400 | | 18,847 |
| Oregon | 2,070 | 470 | 34,223 | 7,111 | 8,342 | | 58,961 |
| Pennsylvania | 36,631 | 160 | 31,312 | 8,000 | 5,738 | | 349,453 |
| Rhode Island | 666 | 745 | 41,018 | | 3,765 | 2,450 | 622,812 |
| South Carolina | 6,665 | 750 | 6,825 | 11,796 | 56,896 | 750 | 247,998 |
| Texas | | 16,875 | 7,200 | 2,067 | 13,294 | | 168,061 |
| Utah | 50 | | | | | | 4,948 |
| Vermont | 544 | | 1,725 | 1,100 | 472 | | 2,934,825 |
| Virginia | 28,477 | 31,790 | 34,981 | 64,386 | 85,077 | | 340,900 |
| Washington | 41,549 | 8,041 | 13,202 | 9,500 | 4,963 | | 459,975 |
| Wisconsin | 1,453 | 555 | 170,192 | | 77,590 | 200 | 798,213 |
| Wyoming | | | | | | | 600 |
| Total | 360,763 | 322,022 | 722,807 | 545,771 | 803,886 | 83,178 | 18,562,806 |

*Value of granite and other igneous rocks produced in the United States in 1906 and 1907, by States and Territories and uses*—Continued.

### 1907.

| State or Territory. | Sold in the rough. | | | Dressed for building. | Dressed for monumental work. | Made into paving blocks. | Curbing. | Flagging. |
|---|---|---|---|---|---|---|---|---|
| | Building. | Monumental. | Other. | | | | | |
| Arizona | $700 | | | | $3,000 | | | |
| Arkansas | | | | | | | $10,973 | |
| California | 35,322 | $49,216 | $6,018 | $485,778 | 80,397 | $133,013 | 107,138 | $2,018 |
| Colorado | 10,516 | 18,041 | | 1,490 | 34,937 | | 2,150 | |
| Connecticut | 31,928 | 26,302 | 838 | 110,600 | 112,393 | 37,606 | 24,551 | 2,357 |
| Delaware | 1,649 | 45 | | 1,470 | | 12,763 | 8,004 | 450 |
| Georgia | 89,675 | 31,100 | 17,050 | 76,252 | 1,000 | 151,181 | 215,758 | 5,515 |
| Hawaii | | | | | | | | |
| Idaho | | 1,800 | | | 5,000 | | 1,750 | |
| Maine | 318,816 | 60,263 | 23,482 | 1,007,572 | 166,789 | 355,462 | 139,148 | 18,742 |
| Maryland | 107,694 | 13,657 | 240 | 55,781 | 8,928 | 56,585 | 23,279 | 13,406 |
| Massachusetts | 267,984 | 337,016 | 39,327 | 907,119 | 66,578 | 319,037 | 87,898 | 4,632 |
| Minnesota | 8,829 | 69,936 | 1,200 | 52,248 | 264,333 | 20,741 | 22,991 | 3,768 |
| Missouri | 342 | 34,530 | | 8,550 | 16,675 | 15,966 | | |
| Montana | 2,000 | 2,000 | | 51,000 | 13,000 | 700 | 4,700 | 2,000 |
| New Hampshire | 49,831 | 90,352 | 36 | 224,269 | 133,601 | 74,978 | 43,944 | 2,865 |
| New Jersey | 4,858 | 105 | 500 | 8,075 | 300 | 1,456 | | |
| New Mexico | | | | | | | | |
| New York | 6,800 | 4,000 | | 31,567 | 7 089 | | 1,686 | |
| North Carolina | 50,062 | 16,010 | 50 | 319,821 | 41,120 | 65,379 | 63,061 | 4,236 |
| Oklahoma | 4,750 | 6,000 | 500 | 7,000 | 700 | | 150 | |
| Oregon | 3,910 | 3,100 | 120 | 1,250 | 9,200 | 8,600 | 1,510 | 18 |
| Pennsylvania | 189,837 | 8,846 | 1,256 | 60,863 | | 21,310 | 7,086 | |
| Rhode Island | 8,125 | 172,396 | 642 | 172,041 | 200,573 | 85,091 | 50 | |
| South Carolina | 9,425 | 50,515 | | 900 | | 5,253 | 18,491 | 25 |
| South Dakota | | | | 690 | | | | |
| Texas | 8,739 | 15,447 | | 14,747 | 44,460 | 25 | 780 | |
| Utah | 782 | 1,658 | 2,000 | | 800 | | | |
| Vermont | 29,764 | 1,122,063 | 6,334 | 1,009,353 | 515,859 | 5,330 | 2,721 | |
| Virginia | 19,350 | 8,039 | | 13,275 | 9,787 | 18,072 | 6,000 | |
| Washington | 7,660 | 34,145 | 16,750 | 126,782 | 1,677 | 917 | 25,802 | |
| Wisconsin | 11,331 | 62,745 | 70,753 | 4,100 | 361,296 | 538,783 | | 9,822 |
| Wyoming | 90 | | | | | | | |
| Total | 1,280,769 | 2,239,327 | 187,096 | 4,752,593 | 2,099,492 | 1,928,308 | 819,621 | 69,854 |

| State or Territory. | Rubble. | Riprap. | Crushed stone. | | | Other. | Total. |
|---|---|---|---|---|---|---|---|
| | | | Road making. | Railroad ballast. | Concrete. | | |
| Arizona | $200 | | | | | $9,800 | $13,700 |
| Arkansas | 25,271 | $13,160 | $6,000 | | $113,592 | | 168,996 |
| California | 191,996 | 36,991 | 79,254 | $5,220 | 40,713 | 53,250 | 1,306,324 |
| Colorado | | | | | | | 67,134 |
| Connecticut | 114,178 | 118,830 | 7,000 | | 3,510 | 1,000 | 591,153 |
| Delaware | 3,033 | 12,184 | 40,298 | 36,668 | 41,628 | | 158,192 |
| Georgia | 26,954 | 925 | 25,000 | 152,297 | 60,896 | 5,000 | 858,603 |
| Hawaii | | | | | 7,599 | 12,000 | 19,599 |
| Idaho | | | 17,392 | | | | 25,942 |
| Maine | 17,025 | 2,998 | 1,511 | 325 | 19,926 | 14,361 | 2,146,420 |
| Maryland | 77,901 | 7,266 | 282,310 | 41,266 | 490,378 | 5,062 | 1,183,753 |
| Massachusetts | 118,308 | 43,900 | 70,585 | 1,086 | 63,297 | 2,010 | 2,328,777 |
| Minnesota | 15,379 | 16,700 | 8,373 | 14,000 | 48,105 | | 546,603 |
| Missouri | | 8,375 | 16,424 | 100 | 35,443 | | 136,405 |
| Montana | 20,650 | 6,000 | | | | | 102,050 |
| New Hampshire | 5,572 | 3,949 | 3,975 | | 14,349 | | 647,721 |
| New Jersey | 500 | | 11,890 | 45,880 | 2,193 | | 75,757 |
| New Mexico | | | | 167,294 | | | 167,294 |
| New York | 762 | 4,900 | 70,750 | 19,300 | 35,591 | 107,277 | 289,722 |
| North Carolina | 6,823 | 2,941 | 53,939 | 175,847 | 106,497 | 690 | 906,476 |
| Oklahoma | 650 | 3,600 | | | 1,200 | | 24,550 |
| Oregon | 614 | | 80,103 | 1,744 | 7,450 | 6 | 117,625 |
| Pennsylvania | 19,801 | 100 | 28,117 | 2,726 | 9,711 | 17,026 | 366,679 |
| Rhode Island | 448 | 1,002 | 25,480 | | 5,550 | 2,750 | 674,148 |
| South Carolina | 13,939 | 25 | 25,887 | 17 | 4,500 | 400 | 129,377 |
| South Dakota | | | | | | | 690 |
| Texas | | 10,000 | 16,000 | | 11,300 | | 122,158 |
| Utah | | | | | | | 5,240 |
| Vermont | 25 | 9 | 2,431 | | | | 2,693,889 |
| Virginia | 16,350 | 28,852 | 59,937 | 50,804 | 167,960 | | 398,426 |
| Washington | 40,818 | 281,936 | 17,930 | | | 7,935 | 562,352 |
| Wisconsin | 801 | 14,790 | 110,072 | | 44,082 | 288 | 1,228,863 |
| Wyoming | | | | | | | 90 |
| Total | 717,998 | 620,033 | 1,060,658 | 714,574 | 1,335,530 | 238,855 | 18,064,708 |

The following table shows the value of the production of granite, including a small output of igneous rocks, in the United States from 1903 to 1907, inclusive:

*Value of granite, etc., produced in the United States, by States and Territories, 1903–1907.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Arizona | $3,000 | $2,500 | $3,700 | $32,042 | $13,700 |
| Arkansas | 47,136 | 52,616 | 90,312 | 118,903 | 168,906 |
| California | 1,161,266 | 1,180,415 | 1,161,330 | 740,784 | 1,306,324 |
| Colorado | 100,791 | 91,132 | 73,802 | 65,402 | 67,134 |
| Connecticut | 871,941 | 558,334 | 636,364 | 974,024 | 591,153 |
| Delaware | 369,166 | 245,272 | 178,428 | 146,346 | 158,192 |
| Georgia | 672,947 | 942,466 | 971,207 | 792,315 | 858,603 |
| Hawaii | ........ | 22,042 | 33,550 | 23,346 | 19,599 |
| Idaho | 2,750 | ........ | 1,500 | 400 | 25,942 |
| Indian Territory | 4,030 | 5,152 | 1,800 | ........ | ........ |
| Maine | 2,586,765 | 2,400,509 | 2,713,795 | 2,560,021 | 2,146,420 |
| Maryland | 837,787 | 815,471 | 957,048 | 883,881 | 1,183,753 |
| Massachusetts | 2,351,027 | 2,554,748 | 2,251,319 | 3,327,416 | 2,328,777 |
| Minnesota | 403,906 | 405,956 | 481,908 | 626,069 | 546,603 |
| Mississippi | ........ | 440 | ........ | ........ | ........ |
| Missouri | 150,409 | 155,716 | 180,579 | 150,009 | 136,405 |
| Montana | 25,993 | 33,890 | 126,430 | 114,005 | 102,050 |
| Nevada | 7,450 | 1,200 | ........ | ........ | ........ |
| New Hampshire | 854,513 | 927,487 | 838,371 | 818,131 | 647,721 |
| New Jersey | 124,135 | 37,197 | 76,758 | 101,224 | 75,757 |
| New Mexico | ........ | ........ | ........ | ........ | 167,294 |
| New York | 159,590 | 196,685 | 134,425 | 304,048 | 289,722 |
| North Carolina | 218,947 | 297,749 | 564,578 | 778,847 | 889,976 |
| Oklahoma | 5,000 | 26,930 | 18,920 | 18,847 | 24,550 |
| Oregon | 118,411 | 235,213 | 85,330 | 58,961 | 117,625 |
| Pennsylvania | 370,551 | 471,528 | 450,619 | 349,453 | 366,679 |
| Rhode Island | 710,291 | 684,952 | 556,364 | 622,812 | 674,148 |
| South Carolina | 476,863 | 382,428 | 297,284 | 247,998 | 129,377 |
| South Dakota | (a) | 900 | ........ | ........ | 690 |
| Texas | 173,325 | 348,317 | 132,193 | 168,061 | 122,158 |
| Utah | 3,803 | 7,980 | 13,630 | 4,948 | 5,240 |
| Vermont | 1,810,179 | 2,447,979 | 2,571,850 | 2,934,825 | 2,693,889 |
| Virginia | 299,335 | 510,788 | 452,390 | 340,900 | 398,426 |
| Washington | 209,095 | 422,508 | 681,730 | 459,975 | 562,352 |
| Wisconsin | 573,391 | 724,422 | 825,625 | 798,213 | 1,228,863 |
| Wyoming | ........ | 557 | ........ | 600 | 90 |
| Total | 15,703,793 | 17,191,479 | 17,563,139 | 18,562,806 | 18,064,708 |

[a] Value of quartzite included in sandstone.

The following table shows the quantity and value of granite paving blocks produced in the United States in 1906 and 1907, by States:

*Number and value of granite paving blocks produced in 1906 and 1907, by States and Territories.*

| State or Territory. | Paving blocks. | | | |
|---|---|---|---|---|
| | 1906. | | 1907. | |
| | Number | Value. | Number. | Value. |
| California | 1,415,000 | $61,115 | 2,674,307 | $133,013 |
| Connecticut | 806,863 | 62,305 | 854,134 | 37,666 |
| Delaware | 162,281 | 7,783 | 298,073 | 12,763 |
| Georgia | 3,927,500 | 123,211 | 5,410,000 | 151,181 |
| Maine | 8,658,437 | 336,979 | 6,292,753 | 355,462 |
| Maryland | 1,126,082 | 51,539 | 901,225 | 56,585 |
| Massachusetts | 4,936,078 | 199,457 | 5,995,040 | 319,037 |
| Minnesota | 744,150 | 50,000 | 315,000 | 20,741 |
| Missouri | 624,453 | 26,295 | 336,007 | 15,966 |
| Montana | ........ | ........ | 10,000 | 700 |
| New Hampshire | 2,298,145 | 89,878 | 1,782,406 | 74,978 |
| New Jersey | 38,567 | 1,216 | 43,426 | 1,456 |
| New York | ........ | ........ | ........ | ........ |
| North Carolina | 974,330 | 33,428 | 1,115,859 | 65,379 |
| Oklahoma | 2,250 | 113 | ........ | ........ |
| Oregon | ........ | ........ | 200,000 | 8,600 |
| Pennsylvania | 455,401 | 19,318 | 442,500 | 21,310 |
| Rhode Island | 834,001 | 42,532 | 1,643,360 | 85,091 |
| South Carolina | 348,615 | 11,340 | 239,086 | 5,253 |
| Texas | 10,000 | 250 | 800 | 25 |
| Vermont | 282,930 | 9,557 | 171,000 | 5,330 |
| Virginia | 1,385,000 | 29,536 | 685,100 | 18,072 |
| Washington | 230,000 | 16,240 | 13,921 | 917 |
| Wisconsin | 5,110,586 | 287,823 | 9,136,584 | 538,783 |
| Total | 34,370,669 | 1,459,915 | 38,560,581 | 1,928,308 |
| Average value per thousand | ........ | 42.48 | ........ | 50.00 |

From this table it appears that there was a considerable increase in the granite paving-block industry in 1907 as compared with 1906. In 1906 the output was 34,370,669 blocks, valued at $1,459,915; in 1907 it was 38,560,581 blocks, valued at $1,928,308, an increase of 4,189,912 blocks in quantity and $468,393 in value. These figures are exclusive of the trap-rock blocks from California, Connecticut, New York, New Jersey, and Pennsylvania.

The average price increased from $42.48 per thousand blocks in 1906 to $50 per thousand in 1907, a gain of $7.52 per thousand. Paving blocks vary in price from $20 per thousand to over $80 per thousand, according to size and regularity of shape.

In many localities, especially in the New England States, paving blocks are cut from the refuse stone of the larger quarries, the cutter paying a small price for the rough stone or paying a certain amount for every thousand cut. Some men go around the country and blast and trim up bowlders and sell the blocks if there is a demand for them. Many of these men are foreigners, and it is almost impossible to get a record of either the number or the value of the blocks they make except through the firms to which they sell, which are often the large quarrymen.

*Granite production of Vermont.*—The following table made out for the forthcoming report of T. Nelson Dale of the United States Geological Survey on the granites of Vermont gives the granite output of Vermont by counties, and also shows the quantity of stone quarried and sold by the producers for building and monumental work during the years 1906 and 1907. This represents practically all the granite quarried and sold in Vermont in these two years, the quantity used for paving blocks and other purposes being practically negligible:

*Production of granite in Vermont in 1906 and 1907, by counties.*

1906.

| County. | Number of firms reporting. | Building. | | | |
|---|---|---|---|---|---|
| | | Rough. | | Dressed. | |
| | | Quantity (cubic feet). | Value. | Quantity (cubic feet). | Value. |
| Washington and Orange | 32 | 66,762 | $42,138 | 234,946 | $771,169 |
| Windsor | 4 | | | 191,793 | 651,693 |
| Caledonia, Essex, and Orleans | 14 | 2,000 | 1,000 | | |
| Windham | 3 | 11,300 | 4,016 | | |
| Total | 53 | 80,062 | 47,154 | 426,739 | 1,422,862 |
| Average value per cu. ft. | | | .59 | | 3.33 |

| County. | Monumental. | | | | Paving. | | Other purposes. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Rough. | | Dressed. | | | | | |
| | Quantity (cubic feet). | Value. | Quantity (cubic feet). | Value. | Quantity (number of blocks). | Value. | Value. | |
| Washington and Orange | 1,006,436 | $879,745 | 110,277 | $428,035 | 112,930 | $3,647 | $9,688 | $2,134,422 |
| Windsor | 2,200 | 3,200 | 14,534 | 22,447 | | | | 677,340 |
| Caledonia, Essex, and Orleans | 206,947 | 110,275 | 1,850 | 740 | | | 700 | 112,715 |
| Windham | | | | | 170,000 | 5,910 | 422 | 10,348 |
| Total | 1,215,583 | 993,220 | 126,661 | 451,222 | 282,930 | 9,557 | 10,810 | 2,934,825 |
| Average value per cu. ft. | | .82 | | 3.56 | | | | |

*Production of granite in Vermont in 1906 and 1907, by counties*—Continued.

1907.

| County. | Number of firms reporting. | Building. | | | |
|---|---|---|---|---|---|
| | | Rough. | | Dressed. | |
| | | Quantity (cubic feet). | Value. | Quantity (cubic feet). | Value. |
| Washington and Orange | 39 | 35,543 | $25,239 | 100,081 | $234,583 |
| Windsor | 4 | | | 204,076 | 774,460 |
| Caledonia and Orleans | 9 | 3,300 | 1,400 | | |
| Windham | 3 | 4,450 | 3,125 | 325 | 310 |
| Total | 55 | 43,293 | 29,764 | 304,482 | 1,009,353 |
| Average value per cu. ft | | | .68 | | 3.31 |

| County. | Monumental. | | | | Paving. | | Other purposes. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Rough. | | Dressed. | | | | | |
| | Quantity (cubic feet). | Value. | Quantity (cubic feet). | Value. | Quantity (number of blocks). | Value. | Value. | |
| Washington and Orange | 1,144,263 | $1,037,993 | 136,103 | $503,759 | 5,000 | $150 | 3,645 | $1,805,369 |
| Windsor | 1,847 | 3,254 | 3,000 | 12,000 | | | | 789,714 |
| Caledonia and Orleans | 143,427 | 77,816 | | | | | 1,751 | 80,967 |
| Windham | 3,371 | 3,000 | 40 | 100 | 166,000 | 5,180 | 6,124 | 17,839 |
| Total | 1,202,908 | 1,122,063 | 139,143 | 515,859 | 171,000 | 5,330 | 11,520 | 2,693,889 |
| Average value per cu. ft | | .93 | | 3.70 | | | | |

It appears that in 1907 there were sold in Vermont 347,775 cubic feet of granite building stone, valued at $1,039,117, and in 1906, 506,801 cubic feet, valued at $1,470,016, a decrease in 1907 of 159,026 cubic feet in quantity and of $430,899 in value.

The figures for monumental stone for the two years were 1,342,051 cubic feet, valued at $1,637,922 in 1907, and 1,342,244 cubic feet, valued at $1,444,442, in 1906, a decrease in 1907 of 193 cubic feet in quantity but an increase of $193,480 in value.

From these figures it will be seen that although the quantity of stone sold for monumental work in 1907 was about four times as great as the quantity sold for building stone, the total value to the quarrymen of the monumental stone increased only one and one-half times. As the table indicates, this is on account of the large quantity of monumental stone sold to the manufacturer in the rough state and the large quantity of building stone sold as dressed stone.

By using the average price per cubic foot of dressed building and dressed monumental stone, it may be calculated that the total value of all the building stone as dressed stone in 1907 was $1,152,653, while the total value of all the monumental stone as dressed or manufactured stone was $4,966,619.

## TRAP ROCK.

In former years the figures of trap rock production in the States of California, Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania, where trap rock has formed a considerable industry, have been included in the totals with granite, although a table has been given showing this production by itself. In this report, however, the trap rock figures for the States named have been segregated, only such trap rock values being left in the granite figures as are included in States where the quantity produced is inappreciable. The California output of trap rock includes a considerable quantity of basalt.

The total output of trap rock in 1907 was valued at $4,594,103; in 1906 it was $3,736,571, an increase of $857,532 for 1907.

The chief gain was in crushed stone, which forms the basis of the trap rock industry and which increased in value from $3,341,863 in 1906 to $4,280,554 in 1907, or $938,691. The quantities corresponding to these values were 5,054,188 short tons in 1906 and 6,073,472 short tons in 1907, an increase in 1907 of 1,019,284 tons. The average value per ton was 66 cents in 1906 and 70 cents in 1907.

In the different crushed stone products the increase was in the value of stone used for road building, particularly in California, due to rebuilding of roads destroyed in 1906 by the earthquake. Crushed stone for railroad ballast also increased in value, but crushed stone for concrete decreased.

For many years New Jersey led in value of trap rock production, and in 1906 was followed by Pennsylvania, New York, California, Massachusetts, and Connecticut, in the order named. In 1907, however, California, for reasons above noted, took first place, followed by New Jersey, New York, Pennsylvania, Connecticut, and Massachusetts.

The following table shows the value of the trap rock output in the United States in 1906 and 1907, by States and uses:

*Value of trap produced in the United States in 1906 and 1907, by States and uses.*

1906.

| State. | Building. | Paving. | Crushed stone. | | | Other. | Total. |
|---|---|---|---|---|---|---|---|
| | | | Road making. | Railroad ballast. | Concrete. | | |
| California | $46,414 | $136,310 | $97,787 | $9,019 | $392,379 | $6,514 | $688,423 |
| Connecticut | 5,162 | 340 | 228,353 | 20,750 | 148,439 | 8,301 | 411,345 |
| Massachusetts | 16,540 | .......... | 286,412 | 28,000 | 131,343 | 500 | 462,795 |
| New Jersey | 17,660 | 52,700 | 432,134 | 92,728 | 245,564 | 16,100 | 856,886 |
| New York | .......... | .......... | 250,215 | 45,000 | 264,076 | 64,144 | 623,435 |
| Pennsylvania | 8,907 | 3,662 | 201,239 | 281,525 | 186,900 | 11,454 | 693,687 |
| Total | 94,683 | 193,012 | 1,496,140 | 477,022 | 1,368,701 | 107,013 | 3,736,571 |

1907.

| State. | Building. | Paving. | Road making. | Railroad ballast. | Concrete. | Other. | Total. |
|---|---|---|---|---|---|---|---|
| California | $4,600 | $132,345 | $435,241 | $89,031 | $356,427 | $12,105 | $1,029,749 |
| Connecticut | 6,052 | 15,110 | 215,206 | 74,660 | 144,825 | 4,100 | 459,953 |
| Massachusetts | 20,947 | .......... | 225,983 | 41,774 | 141,370 | 2,530 | 432,604 |
| New Jersey | 5,369 | 31,126 | 557,655 | 161,367 | 224,587 | 15,332 | 995,436 |
| New York | .......... | 1,500 | 764,582 | 7,367 | 107,090 | 34,856 | 915,395 |
| Pennsylvania | 11,235 | 2,409 | 236,485 | 306,698 | 190,206 | 13,933 | 760,966 |
| Total | 48,203 | 182,490 | 2,435,152 | 680,897 | 1,164,505 | 82,856 | 4,594,103 |

The following table shows the quantity and value of trap paving blocks produced in the United States in 1906 and 1907, by States:

*Number and value of trap paving blocks produced in the United States, 1906–7, by States.*

| State. | Paving blocks. | | | |
|---|---|---|---|---|
| | 1906. | | 1907. | |
| | Number. | Value. | Number. | Value. |
| California | 3,080,391 | $136,310 | 2,494,989 | $132,345 |
| Connecticut | 17,015 | 340 | 474,580 | 15,110 |
| New Jersey | 1,714,200 | 52,700 | 1,107,000 | 31,126 |
| New York | .......... | .......... | 50,000 | 1,500 |
| Pennsylvania | 88,084 | 3,662 | 55,900 | 2,409 |
| Total | 4,899,690 | 193,012 | 4,182,469 | 182,490 |
| Average price per thousand | .......... | 39 | .......... | 41 |

## SANDSTONE.

Since 1903 sandstone has shown more perhaps than any other kind of stone the effect of the use of cement and concrete for foundations, buildings, paving, flagging, and curbing, and the use of concrete blocks for buildings; and in 1907 it was particularly affected by the general financial depression. The chief use of sandstone is as building stone, and the decrease in this use was so great that it was not offset, as in limestone and to some extent in granite, by any large increase in output for some other purpose. Sandstone, however, for all other uses increased in value in 1907 as compared with 1906.

The total value of the sandstone production was $8,871,678 in 1907 and $9,169,337 in 1906, a decrease of $297,659 in 1907. The total value for 1907 is the smallest since 1901, when the value of the output was $8,138,680. Pennsylvania, New York, and Ohio with total values, respectively, of $2,064,913, $1,978,117, and $1,591,148 in 1907, were the principal sandstone-producing States. The next States in order of value of output were California, Minnesota, Colorado, Washington, and Massachusetts, with values ranging from $437,738 to $243,323. In 1906 the production of the three ranking States, Pennsylvania, New York, and Ohio, was valued at $2,724,874, $1,905,892, and $1,426,645, respectively, showing an increase for 1907 of $72,225 for New York and of $164,503 for Ohio, and a decrease of $659,961 for Pennsylvania. The next States in rank in 1906 were California, Colorado, Minnesota, Massachusetts, and New Jersey, with values of production ranging from $642,166 to $215,142.

In New York and Pennsylvania part of the sandstone output is known to the trade as bluestone, the production of which is given in a separate table. The output of New York also includes in 1906 and 1907 a small value for Connecticut.

*Building stone.*—Building stone, rough and dressed, was valued at $3,154,783 in 1907 and at $4,275,669 in 1906, a decrease in 1907 of $1,120,886. The decrease was general for all States producing any quantity of this class of material, with the exception of Washington, West Virginia, and Wisconsin, which States showed increase. The decrease in Pennsylvania is especially noticeable. A large quantity of the Pennsylvania stone is ordinarily used by railroad companies in building bridges, and in 1907 this work was either practically stopped or cement or concrete was substituted for stone. California sandstone also showed a decided decrease instead of the recovery noticed for the other varieties of stone.

The leading States in production of building stone were Pennsylvania, Ohio, New York, and California, with values respectively of $651,147, $602,001, $546,415, and $229,771. In 1906 the values were: Pennsylvania, $1,346,140; New York, $724,164; Ohio, $659,611; California, $400,083; a decrease of $694,993 for Pennsylvania, of $57,610 for Ohio, of $177,749 for New York, and of $170,312 for California.

*Ganister.*—Ganister reported from Pennsylvania, Wisconsin, Colorado, Maryland, Ohio, and Illinois, according to rank of value of output, was valued at $308,520 in 1907, as against $284,066 in 1906, a gain of $24,454.

*Paving.*—Sandstone for paving increased in value from $694,995 in 1906 to $884,843 in 1907, a gain of $189,848. This class of stone consists chiefly of the bluestone of New York and Pennsylvania with a considerable output from Minnesota, Washington, and South Dakota.

*Curbing.*—Curbing was valued at $1,380,516 in 1907, as against $1,074,369 in 1906, an increase of $306,147. New York, Ohio, and Pennsylvania, the principal producers of this material, showed marked increases in value. The New York and Pennsylvania production was chiefly bluestone.

*Flagging.*—There was a small increase in the output of flagging from $1,097,438 in 1906 to $1,185,879 in 1907, a gain of $88,441. Ohio, New York, and Pennsylvania were the largest producers, New York and Pennsylvania decreasing in output, and Ohio increasing.

*Rubble.*—Rubble increased in value $31,332, from $525,108 in 1906 to $556,440 in 1907.

*Riprap.*—The value of the sandstone used for riprap increased from $231,654 in 1906 to $289,419 in 1907, an increase of $57,765.

*Crushed stone.*—Sandstone for crushed stone increased in value in 1907 only to a small extent in comparison with the other varieties of stone. In 1907, the production was 1,336,314 short tons, valued at $987,528, as against 1,257,508 short tons, valued at $889,894 in 1906, an increase of 78,806 tons in quantity and of $97,634 in value. The average price per ton was 71 cents in 1906 and 74 cents in 1907. The largest part of the output is used for concrete and roadmaking. Pennsylvania, California, and Massachusetts were the largest producers.

The total output dues not include sandstone made into abrasives, such as grindstones, whetstones, oilstones, and pulpstones, nor does it include sandstone ground into sand and used for glass sand, molding sand, or polishing sand.

The following table shows the value of the sandstone production in the United States from 1903 to 1907, inclusive, by States and Territories:

*Value of sandstone production in the United States, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | $42,933 | $12,788 | $28,107 | $40,467 | $48,673 |
| Arizona | 526,875 | 91,960 | 65,558 | 33,149 | 158,435 |
| Arkansas | 61,172 | 63,950 | 58,161 | 55,703 | 94,275 |
| California | 762,327 | 735,662 | 685,668 | 642,166 | 437,738 |
| Colorado | 389,132 | 281,142 | 453,029 | 286,544 | 299,443 |
| Connecticut | 119,417 | 117.696 | 62,618 | (a) | (a) |
| Idaho | 11,856 | 9,320 | 22,265 | 11,969 | 24,001 |
| Illinois | 26,293 | 47,377 | 29,115 | 19,125 | 14,906 |
| Indiana | 32,651 | 22,681 | 15,421 | 30,740 | 15,425 |
| Indian Territory | .......... | .......... | 2,198 | 615 | .......... |
| Iowa | 19,011 | 9,300 | 9,335 | 5,600 | 3,542 |
| Kansas | 102,128 | 130,516 | 79,617 | 42,809 | 46,831 |
| Kentucky | 93,742 | 93,622 | 280,579 | 125,123 | 98,450 |
| Louisiana | .......... | 8,315 | .......... | .......... | .......... |
| Maryland | 2,170 | 8,998 | 12,984 | 9,533 | 13,859 |
| Massachusetts | 372,478 | 320,861 | 367.461 | 260,721 | 243,323 |
| Michigan | 121,350 | 74,868 | 123,123 | 65,395 | 53,003 |
| Minnesota | 363,262 | 319,209 | 294,640 | 285,433 | 300,204 |
| Missouri | 49,402 | 44,455 | 27,686 | 20,951 | 35,289 |
| Montana | 68,036 | 64,232 | 45,116 | 37,462 | 39,216 |
| Nebraska | 1,067 | 142 | 120 | 6,899 | 11,609 |
| Nevada | 2,370 | 10,558 | 1,500 | .......... | .......... |
| New Jersey | 364,337 | 236,426 | 294,719 | 215,142 | 177,667 |
| New Mexico | 7,510 | 133,390 | 101,522 | 42,574 | 12,450 |
| New York | [b]1,756,501 | [b]1,755,524 | [b]1,831,756 | [b c]1,905,892 | [b c]1,978,117 |
| North Carolina | 600 | 250 | 4,483 | 3,531 | 4,105 |
| North Dakota | .......... | .......... | 1,055 | 44 | 3,260 |
| Ohio | 1,793,379 | 1,808,062 | 1,744,472 | 1,426,645 | 1,591,148 |
| Oklahoma | 6,500 | 2,995 | 12,914 | 40,246 | 43,403 |
| Oregon | 2,912 | 6,186 | 1,229 | 25,950 | 3,904 |
| Pennsylvania | [b]3,255,073 | [b]2,641,510 | [b]2,487,939 | [b]2,724,874 | [b]2,064,913 |
| South Dakota | 163,067 | 338,970 | 193,408 | 145,966 | 143,585 |
| Tennessee | 20,649 | 24,868 | 8,715 | 14,136 | 16,523 |
| Texas | 114,381 | 209,313 | 123,281 | 111,533 | 108,047 |
| Utah | 71,279 | 70,168 | 43,429 | 137,529 | 24,298 |
| Virginia | 4,471 | 13,522 | 2,000 | 5,100 | (d) |
| Washington | 47,430 | 88,185 | 124,910 | 169,500 | 295,585 |
| West Virginia | 252,204 | 287,381 | 171,309 | 113,369 | [e]197,926 |
| Wisconsin | 142,445 | 158,503 | 161,741 | 181,986 | 236,183 |
| Wyoming | 91,849 | 30,986 | 33,591 | 24,715 | 32,252 |
| Total | 11,262,259 | 10,273,891 | 10,006,774 | 9,169,337 | 8,871,678 |

[a] Included in New York.
[b] Includes bluestone.
[c] Includes Connecticut.
[d] Included in West Virginia.
[e] Includes a small value for Virginia.

The following table shows the value of the sandstone production of the United States in 1906 and 1907, by States and Territories and uses:

*Value of sandstone production in the United States in 1906 and 1907, by States and Territories and uses.*

1906.

| State or Territory. | Rough building. | Dressed building. | Ganister. | Paving. | Curbing. | Flagging. | Rubble. |
|---|---|---|---|---|---|---|---|
| Alabama |  |  |  |  |  |  | $14,975 |
| Arizona | $4,358 |  |  |  |  |  | 1,036 |
| Arkansas | 2,879 | $1,746 |  | $25 | $19,873 | $4,636 | 2,225 |
| California | 100,483 | 209,600 |  |  | 8,642 |  | 18,050 |
| Colorado | 67,139 | 15,301 | $40,522 | 16,225 | 44,543 | 33,703 | 29,655 |
| Connecticut |  |  |  |  |  |  |  |
| Idaho | 5,088 | 756 |  |  |  |  | 6,125 |
| Illinois | 7,735 | 4,885 | 1,500 | 2,500 | 50 | 50 | 1,500 |
| Indiana | 4,550 | 19,240 |  |  | 4,250 | 150 | 1,350 |
| Indian Territory | 467 |  |  | 8 |  |  | 140 |
| Iowa | 4,184 | 30 |  |  | 113 | 30 | 460 |
| Kansas | 23,496 | 700 |  | 2,450 | 6,297 | 6,546 | 1,975 |
| Kentucky | 64,161 | 41,762 |  | 1,200 | 1,800 | 1,875 | 3,450 |
| Maryland | 3,661 |  | 5,760 |  | 4 |  |  |
| Massachusetts | 53,016 | 52,402 |  |  |  |  | 6,860 |
| Michigan | 35,272 | 18,950 |  |  |  |  | 10,403 |
| Minnesota | 13,112 | 58,789 |  | 72,012 | 42,193 | 2,708 | 31,209 |
| Missouri | 6,802 | 7,298 |  | 100 | 318 | 418 | 3,115 |
| Montana | 4,257 | 30,477 |  |  |  |  | 2,110 |
| Nebraska | 374 |  |  | 7 |  |  |  |
| New Jersey | 119,413 | 21,250 |  | 500 | 2,960 | 5,650 | 45,000 |
| New Mexico | 4,040 | 3,225 |  |  | 375 |  | 3,010 |
| New York | 230,102 | 494,062 |  | 374,278 | 375,539 | 306,423 | 48,362 |
| North Carolina |  | 2,000 |  |  |  |  | 895 |
| North Dakota | 10 |  |  | 20 |  |  | 4 |
| Ohio | 310,256 | 349,355 | 6,750 | 350 | 251,509 | 383,457 | 36,696 |
| Oklahoma | 22,908 | 8,650 |  |  | 60 | 115 | 6,263 |
| Oregon | 25,845 | 105 |  |  |  |  |  |
| Pennsylvania | 510,299 | 835,841 | 196,804 | 112,456 | 305,470 | 277,623 | 152,971 |
| South Dakota | 26,101 | 30,356 |  | 32,300 | 320 | 654 | 27,875 |
| Tennessee | 250 | 10,531 |  |  | 150 | 75 | 3,000 |
| Texas | 8,713 | 21,302 |  |  | 630 |  | 5,903 |
| Utah | 600 | 2,014 |  | 10,750 | 400 | 20 | 17,645 |
| Virginia | 1,250 | 250 |  |  |  |  |  |
| Washington | 41,982 | 59,700 |  | 62,922 |  |  | 2,410 |
| West Virginia | 27,169 | 32,186 |  | 592 | 8,125 | 10,185 | 14,418 |
| Wisconsin | 21,071 | 82,357 | 32,730 | 100 | 758 | 1,120 | 23,084 |
| Wyoming | 14,606 | 4,900 |  | 200 |  | 2,000 | 2,934 |
| Total | 1,765,649 | 2,510,020 | 284,066 | 694,995 | 1,074,309 | 1,097,438 | 525,108 |

*Value of sandstone production in the United States in 1906 and 1907, by States and Territories and uses*—Continued.

1906—Continued.

| State or Territory. | Riprap. | Crushed stone. | | | Other. | Total. |
|---|---|---|---|---|---|---|
| | | Road making. | Railroad ballast. | Concrete. | | |
| Alabama | $25,492 | | | | | $40,467 |
| Arizona | 1,625 | | | | $26,130 | 33,149 |
| Arkansas | 350 | $977 | | $22,952 | 40 | 55,708 |
| California | 63 | 178,548 | $585 | 33,942 | 2,253 | 642,166 |
| Colorado | 1,314 | | 7,600 | 25,027 | 5,515 | 286,544 |
| Connecticut | | | | | | ([a]) |
| Idaho | | | | | | 11,969 |
| Illinois | 705 | 200 | | | | 19,125 |
| Indiana | 1,200 | | | | | 30,740 |
| Indian Territory | | | | | | 615 |
| Iowa | 32 | 150 | | | 602 | 5,601 |
| Kansas | | | | | 1,345 | 42,809 |
| Kentucky | 2,875 | | 7,500 | 500 | | 125,123 |
| Maryland | | 8 | | 100 | | 9,533 |
| Massachusetts | | 33,208 | | 112,885 | 2,350 | 260,721 |
| Michigan | 770 | | | | | 65,395 |
| Minnesota | 7,531 | 11,619 | | 37,918 | 8,542 | 285,633 |
| Missouri | 1,400 | | | | 1,500 | 20,951 |
| Montana | 465 | | | | 153 | 37,462 |
| Nebraska | 6,500 | | | 18 | | 6,899 |
| New Jersey | 1,000 | 9,400 | 200 | 3,150 | 6,629 | 215,142 |
| New Mexico | | | 30,324 | | 1,600 | 42,574 |
| New York | 2,040 | 6,600 | | 2,365 | 6,121 | [b] 1,905,892 |
| North Carolina | | | | | 636 | 3,531 |
| North Dakota | | | | | 10 | 44 |
| Ohio | 38,350 | 6,800 | 19,300 | 13,575 | 10,247 | 1,426,645 |
| Oklahoma | 50 | 50 | | 2,075 | 75 | 40,246 |
| Oregon | | | | | | 25,950 |
| Pennsylvania | 66,626 | 34,000 | 108,391 | 103,120 | 21,273 | 2,724,574 |
| South Dakota | 13,964 | 180 | 157 | 14,000 | 59 | 145,966 |
| Tennessee | | | 100 | | 30 | 14,136 |
| Texas | 40,983 | 9,000 | 1,000 | 23,850 | 152 | 111,533 |
| Utah | | | | | 100 | 37,529 |
| Virginia | | | | 3,600 | | 5,100 |
| Washington | 1,923 | | | | 563 | 169,500 |
| West Virginia | 1,076 | 3,734 | 3,500 | 12,105 | 219 | 113,369 |
| Wisconsin | 15,320 | 5,403 | | 43 | | 181,986 |
| Wyoming | | | | 75 | | 24,715 |
| Total | 231,654 | 299,877 | 178,717 | 411,300 | 96,144 | 9,169,337 |

[a] Included in New York.

[b] Includes Connecticut.

*Value of sandstone produced in the United States in 1906 and 1907, by States and Territories, and uses*—Continued.

1907.

| State or Territory. | Rough building. | Dressed building. | Ganister | Paving. | Curbing. | Flagging. | Rubble. |
|---|---|---|---|---|---|---|---|
| Alabama |  |  |  |  |  |  | $4,095 |
| Arizona | $3,113 |  |  |  |  |  | 60,427 |
| Arkansas | 3,680 | $800 |  | $525 | $16,095 | $950 | 4,325 |
| California | 14,318 | 215,453 |  | 4,761 | 3,950 | 3,600 | 20,207 |
| Colorado | 67,020 | 10,283 | $35,100 | 25,638 | 36,987 | 46,974 | 32,792 |
| Connecticut |  |  |  |  |  |  |  |
| Idaho | 12,739 | 5,525 |  |  |  |  | 5,737 |
| Illinois | 6,464 | 4,120 | 1,900 | 375 |  | 50 | 1,639 |
| Indiana | 5,600 | 2,000 |  | 977 | 325 | 73 | 4,850 |
| Iowa | 2,765 |  |  |  |  |  | 606 |
| Kansas | 11,037 | 600 |  | 28 | 13,112 | 20,027 | 1,204 |
| Kentucky | 37,210 | 38,170 |  | 2,700 | 1,120 | 3,000 | 8,601 |
| Maryland | 1,769 | 30 | 10,200 |  | 1,643 |  | 100 |
| Massachusetts | 38,779 | 52,729 |  | 750 |  |  | 10,215 |
| Michigan | 33,561 | 10,918 |  |  |  | 528 | 7,900 |
| Minnesota | 9,438 | 109,270 |  | 78,211 | 19,440 | 1,968 | 32,450 |
| Missouri | 17,292 | 7,911 |  | 50 | 150 | 325 | 2,940 |
| Montana | 8,550 | 26,357 |  |  |  |  | 2,829 |
| Nebraska | 1,409 |  |  |  |  |  | 400 |
| New Jersey | 83,513 | 30,750 | 455 | 840 | 240 | 4,800 | 47,000 |
| New Mexico | 2,640 | 1,460 |  |  | 50 | 100 | 7,900 |
| New York | 144,673 | 401,742 |  | 368,697 | 621,934 | 361,383 | 22,454 |
| North Carolina |  | 2,650 |  |  |  |  | 455 |
| North Dakota | 3,200 |  |  | 60 |  |  |  |
| Ohio | 228,777 | 373,224 | 5,500 | 1,408 | 336,974 | 469,072 | 45,041 |
| Oklahoma | 8,758 | 160 |  | 16 | 85 | 210 | 5,354 |
| Oregon | 3,306 | 48 |  |  | 21 |  |  |
| Pennsylvania | 181,914 | 469,233 | 206,661 | 145,629 | 315,307 | 270,227 | 116,109 |
| South Dakota | 17,288 | 14,745 |  | 60,015 | 335 | 584 | 19,458 |
| Tennessee | 795 | 13,000 |  |  | 90 |  | 2,240 |
| Texas | 12,680 | 12,562 |  |  | 450 |  | 11,200 |
| Utah | 5,353 | 1,002 |  | 15,660 |  |  | 583 |
| Virginia |  |  |  |  |  |  |  |
| Washington | 16,680 | 95,640 |  | 175,285 |  |  | 750 |
| West Virginia | 46,263 | 59,609 |  | 3,085 | 12,038 |  | 42,021 |
| Wisconsin | 56,566 | 86,267 | 48,704 | 333 |  | 1,408 | 25,156 |
| Wyoming | 18,850 | 2,525 |  |  | 170 | 600 | 9,402 |
| Total | 1,106,000 | 2,048,783 | 308,520 | 884,843 | 1,380,516 | 1,185,879 | 556,440 |

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*Value of sandstone produced in the United States in 1906 and 1907, by States and Territories, and uses*—Continued.

1907—Continued.

| State or Territory. | Riprap. | Crushed stone. | | | Other. | Total. |
|---|---|---|---|---|---|---|
| | | Road making. | Railroad ballast. | Concrete. | | |
| Alabama | $44,578 | | | | | $48,673 |
| Arizona | 250 | | | $41,645 | $53,000 | 158,435 |
| Arkansas | 1,350 | $375 | | 66,025 | 150 | 94,275 |
| California | 2,880 | 108,244 | $163 | 64,162 | | 437,738 |
| Colorado | 4,064 | 900 | 21,580 | 18,095 | 10 | 299,443 |
| Connecticut | | | | | | (a) |
| Idaho | | | | | | 24,001 |
| Illinois | 418 | | | | 30 | 14,996 |
| Indiana | 1,600 | | | | | 15,425 |
| Iowa | 171 | | | | | 3,542 |
| Kansas | | | | | 823 | 46,831 |
| Kentucky | 2,022 | 1,572 | | 1,130 | 2,925 | 98,450 |
| Maryland | | | | 117 | | 13,859 |
| Massachusetts | | 18,653 | | 122,197 | | 243,323 |
| Michigan | 96 | | | | | 53,003 |
| Minnesota | 8,364 | 31,510 | | 1,978 | 7,575 | 300,204 |
| Missouri | 3,600 | | | | 3,021 | 35,289 |
| Montana | 1,246 | | | | 234 | 39,216 |
| Nebraska | 9,750 | | | 50 | | 11,609 |
| New Jersey | | 5,550 | | 4,519 | | 177,667 |
| New Mexico | | 300 | | | | 12,450 |
| New York | 1,933 | 35,549 | | 8,225 | 11,527 | b c1,978,117 |
| North Carolina | | | | | 1,000 | 4,105 |
| North Dakota | | | | | | 3,260 |
| Ohio | 54,222 | 12,357 | 21,200 | 21,118 | 22,255 | 1,591,148 |
| Oklahoma | 2,700 | | 26,000 | | 120 | 43,403 |
| Oregon | 427 | 102 | | | | 3,904 |
| Pennsylvania | 99,518 | 75,496 | 88,960 | 80,986 | 14,873 | c2,064,913 |
| South Dakota | 15,360 | 14,000 | | | 1,800 | 143,585 |
| Tennessee | | 94 | | | 304 | 16,523 |
| Texas | 15,555 | | 21,850 | 33,750 | | 108,047 |
| Utah | | | | | 1,700 | 24,298 |
| Virginia | | | | | | (d) |
| Washington | 6,730 | | 500 | | | 295,585 |
| West Virginia | 4,901 | 240 | 1,220 | 27,845 | 704 | e197,926 |
| Wisconsin | 7,534 | 7,455 | | 1,381 | 1,379 | 236,183 |
| Wyoming | 150 | 60 | | 375 | 120 | 32,252 |
| Total | 289,419 | 312,457 | 181,473 | 493,598 | 123,750 | 8,871,678 |

a Included in New York.
b Includes Connecticut.
c Includes bluestone.
d Included in West Virginia.
e Includes small output for Virginia.

## BLUESTONE.

Bluestone as quarried in New York and Pennsylvania increased somewhat in value in 1907, although producers and dealers generally reported lack of demand, and therefore of production, on account of financial conditions.

Bluestone forms a prominent industry in northeastern Pennsylvania and eastern New York. This stone is quarried by a large number of small quarrymen, who, at unoccupied intervals, get out this stone and sell it to large dealers. These large buyers of stone also quarry for themselves, and the best figures of production are obtained from them. Besides this a considerable quantity is sold for local use, especially for flagging and curbing, and difficulty is experienced in getting reports for this stone, as very few of the small producers keep records of the sales made by them.

The bluestone output of New York and Pennsylvania in 1906 represented 22.05 per cent of the total sandstone output in the United States; in 1907 it was 23.87 per cent. New Jersey also produced sandstone known to the trade as bluestone, but this output is included in sandstone.

The total value for 1907 was $2,117,916, as against $2,021,898 for 1906, an increase for 1907 of $96,018. The output from New York increased in value from $1,138,934 in 1906 to $1,356,555 in 1907, or $217,621; the output of Pennsylvania decreased from $882,964 in 1906 to $761,361 in 1907, a decrease of $121,603.

Bluestone for building purposes decreased in value from $760,842 in 1906 to $585,341 in 1907, or $175,501. Both States decreased in value of production.

Flagging increased in value from $630,964 in 1906 to $721,568 in 1907, an increase of $90,604. New York increased in value of output and Pennsylvania decreased.

Curbing increased in value from $405,894 in 1906 to $560,403 in 1907, a gain of $154,509, New York increasing and Pennsylvania decreasing in value of output. Bluestone for crushed stone and for other minor purposes increased slightly in 1907.

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1906 and 1907:

*Value and uses of bluestone produced in New York and Pennsylvania in 1906 and 1907.*

| State. | Building purposes. | Flagging. | Curbing. | Crushed stone. | Other purposes. | Total value. |
|---|---|---|---|---|---|---|
| **1906.** | | | | | | |
| New York | $492,552 | $365,483 | $235,791 | $600 | $44,508 | $1,138,934 |
| Pennsylvania | 268,290 | 265,481 | 170,103 | 54,994 | 124,096 | 882,964 |
| Total | 760,842 | 630,964 | 405,894 | 55,594 | 168,604 | 2,021,898 |
| **1907.** | | | | | | |
| New York | $374,369 | $468,045 | $431,663 | $2,675 | $79,803 | $1,356,555 |
| Pennsylvania | 210,972 | 253,523 | 128,740 | 54,552 | 113,574 | 761,361 |
| Total | 585,341 | 721,568 | 560,403 | 57,227 | 193,377 | 2,117,916 |

## MARBLE.

The marble output in the United States was valued at $7,837,685 in 1907, as against $7,582,938 in 1906, a gain of $254,747.

The commercial output of marble in the United States is from Vermont, New York, Georgia, Tennessee, Massachusetts, California, Pennsylvania, Maryland, Alabama, Alaska, Oklahoma, Kentucky, New Mexico, Utah, Washington, and Idaho, named in order of value of output.

Vermont in 1907 produced 58.65 per cent of the marble output of the United States. The Vermont output was valued at $4,596,724, representing about 1,450,000 cubic feet; in 1906 the value of the production was $4,576,913, or 60.36 per cent of the total, and represented approximately 1,400,000 cubic feet. Vermont marble is used largely both for outside building and monumental work and also for interior decorations in buildings, for electrical work, mosaic work, etc., and is sold by the producers principally as dressed stone.

New York, exceeding Georgia, ranked second in 1907, with a value of $911,951 as compared with $557,954 in 1906, an increase of $353,997. The output for 1907 represented 11.64 per cent of the total.

Georgia, which ranked second in 1906, ranked third in 1907, with an output valued at $864,757 as against $919,356 in 1906—a decrease in 1907 of $54,599. In 1906 the value represented about 875,000 cubic feet and in 1907 about 807,000 cubic feet. Most of the marble of this State is sold rough by the quarrymen to the manufacturers. The demand for building marble was reported as very light after the first of September, the output thus remaining practically as in 1906.

Of the other States, Alabama, Alaska, California, New Mexico, Tennessee, and Utah increased in value of output, while Maryland, Massachusetts, Nevada, Pennsylvania, and Wyoming decreased.

Alabama marble, which has recently entered the market, has found favor both as a building and as a monumental stone. Alaska showed a healthy increase in value of output, a description of the quarries being given by Chas. W. Wright [a] in Bulletin 345 of the United States Geological Survey.

From Colorado development work and installation of machinery was reported on marble and onyx property in Gunnison County, but there has been as yet no commercial output.

The Idaho output was very small and only used locally for building and for burning into lime.

The Kentucky output was "onyx" marble from Cave City, Barren County.

Development work was done on deposits of marble in Nevada in 1907 and some marble will probably be shipped in 1908. A description of a Nevada marble deposit is given in Bulletin 340 of the United States Geological Survey.[b]

The output from Oklahoma is from Marble City, Sequoyah County.

*Building stone.*—The value of building marble, rough and dressed, was $2,859,237 in 1907, an increase of $76,617 over the value for 1906, which was $2,782,620. The total for 1907 includes $954,092 for rough building and $1,905,145 for dressed building; in 1906 the rough building marble sold was valued at $1,222,695 and the dressed building stone at $1,559,925, a decrease in 1907 of $268,603 for rough stock, and an increase of $345,220 for dressed marble. The value of Vermont's production of marble for building was $1,204,212, or 42.12 per cent of the total. This was chiefly dressed stone. New York, whose output is represented principally by dressed building marble, produced 25.80 per cent of the total building stone, with a value of $737,634. The Georgia output was valued at $433,457, or 15.16 per cent of the total. This was almost entirely for rough stone.

*Monumental stone.*—Monumental marble was valued at $2,640,130 in 1907, and at $2,657,813 in 1906, a decrease of $17,683 for 1907. In 1907 the value of rough stock was $596,130 and of dressed monumental stone $2,044,000; the corresponding figures for 1906 were $442,941 for rough monumental stock and $2,214,872 for dressed monumental stone, an increase in 1907 of $153,189 in value of rough stock and a decrease of $170,872 for dressed stone.

Vermont, with a value of $2,044,029, produced 77.42 per cent of the total monumental marble; Georgia produced 13.36 per cent; and New York, with 5.11 per cent, ranked third.

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[a] Mineral Resources of Alaska, 1907, Report on Progress of Investigations in 1907, by A. H. Brooks and others: Bull. U. S. Geol. Survey, No. 345, 1908.

[b] Darton, N. H., Investigations relating to building stones by the United States Geological Survey in 1907: Contributions to Economic Geology, pt. I, Bull. U. S. Geol. Survey, No. 340, 1908.

*Interior work.*—Vermont, Tennessee, California, and Massachusetts produced most of the marble for interior work, the total value for 1907 being $1,900,952, as against $1,722,445 for 1906, an increase of $178,507 for 1907.

*Other marble.*—Rough stone for other purposes includes waste stone sold to lime burners, carbonic-acid factories, pulp mills, and for road material; and dressed stone includes stone for mosaics and electrical work.

The following table shows the value of the marble production in 1906 and 1907 by States and Territories and uses:

*Value of the marble product, 1906 and 1907, by States and Territories and uses.*

**1906.**

| State or Territory. | Rough. | | | Dressed. | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Building. | Monumental. | Other purposes. | Building. | Monumental. | Ornamental. | Interior decoration. | Other purposes. | |
| Alabama | $26,500 | | | $48,500 | $10,000 | | | | $85,000 |
| Alaska | | | | | | | | | (a) |
| Arkansas | 7,000 | $2,400 | | 7,500 | | | | | 16,900 |
| California | 10,638 | 5,210 | | 2,400 | 8,300 | $2,000 | $73,000 | $1,500 | 103,048 |
| Georgia | 425,356 | 332,500 | $75,000 | 62,500 | 24,000 | | | | 919,356 |
| Maryland | 91,000 | 16,400 | 9,495 | 59,600 | | | | | 176,495 |
| Massachusetts | 1,995 | 15 | 10,600 | 113,380 | 100 | | 140,844 | 5,000 | 271,934 |
| Missouri | | | | | | | | | (b) |
| Nevada | 5,000 | | | | | | | | 5,000 |
| New Mexico | | 500 | | | | | | | 500 |
| New York | 240,853 | 30,200 | 21,846 | 122,860 | 140,195 | | 2,000 | | 557,954 |
| Pennsylvania | 16,306 | 560 | 4,000 | 125,766 | 13,500 | 5,000 | 6,500 | | 171,632 |
| Tennessee | 210,421 | | | 40,100 | 6,000 | | 358,100 | 21,200 | 635,821 |
| Utah | | 1,400 | | | | | | | 1,400 |
| Vermont | 186,626 | 52,756 | 4,607 | 977,319 | 2,007,777 | 32,523 | 1,097,001 | 218,304 | 4,576,913 |
| Washington | | 1,000 | 3,985 | | 5,000 | 5,000 | 45,000 | | c 59,985 |
| Wyoming | 1,000 | | | | | | | | 1,000 |
| Total | 1,222,695 | 442,941 | 129,533 | 1,559,925 | 2,214,872 | 44,523 | 1,722,445 | 246,004 | 7,582,938 |

**1907.**

| State or Territory. | Rough. | | | Dressed. | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Building. | Monumental. | Other purposes. | Building. | Monumental. | Ornamental. | Interior decoration. | Other purposes. | |
| Alabama | $67,780 | | $1,226 | $4,537 | $8,900 | | $2,500 | $532 | $85,475 |
| Alaska | 35,250 | | | | 2,660 | | 200 | | 38,110 |
| California | 20,054 | $3,100 | 1,500 | 429 | 4,500 | | 153,702 | | 183,285 |
| Georgia | 385,704 | 334,600 | 76,700 | 47,753 | 18,000 | | 2,000 | | 864,757 |
| Idaho | | | | | | | | | (d) |
| Kentucky | | | | | | | 12,500 | | 12,500 |
| Maryland | 25,653 | 6,400 | 2,040 | 41,750 | 10,180 | | 10,000 | 2,895 | 98,918 |
| Massachusetts | 242 | | 2,493 | 61,800 | 35,050 | $811 | 97,542 | 14,500 | 212,438 |
| Missouri | | | | | | | | | (e) |
| Nevada | | | | | | | | | |
| New Mexico | 2,000 | 1,050 | 560 | 1,500 | 1,000 | 200 | 625 | 600 | f 7,535 |
| New York | 147,119 | 68,565 | 19,624 | 590,515 | 66,286 | | 10,000 | 9,842 | 911,951 |
| Oklahoma | 15,000 | 1,325 | | | | | 480 | | 16,805 |
| Pennsylvania | 17,667 | 1,250 | 3,800 | 53,587 | 17,235 | | | 25,000 | 118,539 |
| Tennessee | 111,185 | 10,500 | 39,500 | 25,500 | 3,000 | | 427,463 | 71,000 | 688,148 |
| Utah | | | | | 2,500 | | | | 2,500 |
| Vermont | 126,438 | 169,340 | 226 | 1,077,774 | 1,874,689 | 24,039 | 1,183,940 | 140,278 | 4,596,724 |
| Washington | | | | | | | | | (d) |
| Wyoming | | | | | | | | | |
| Total | 954,092 | 596,130 | 147,669 | 1,905,145 | 2,044,000 | 25,050 | 1,900,952 | 264,647 | 7,837,685 |

[a] Included in Washington.
[b] Included in limestone to prevent disclosure of individual figures.
[c] Includes Alaska.
[d] Included in New Mexico.
[e] Included in limestone.
[f] Includes Idaho and Washington.

The following table shows the value of the marble produced in the United States from 1903 to 1907, inclusive, by States and Territories:

*Value of marble produced in the United States, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | (a) | (a) | | $85,000 | $85,475 |
| Alaska | | (a) | $710 | (b) | 38,110 |
| Arizona | (a) | (a) | | | |
| Arkansas | | (a) | 1,000 | 16,900 | |
| California | $78,329 | $87,659 | 95,540 | 103,048 | 183,285 |
| Connecticut | (a) | (a) | | | |
| Georgia | 565,605 | 690,714 | 774,550 | 919,356 | 864,757 |
| Idaho | | | | | (c) |
| Kentucky | | | | | 12,500 |
| Maryland | 83,672 | 73,814 | 138,404 | 176,495 | 98,918 |
| Massachusetts | 154,228 | 183,388 | 166,360 | 271,934 | 212,438 |
| Missouri | (a) | (a) | | (d) | (d) |
| Nevada | | | | 5,000 | |
| New Mexico | (a) | 4,250 | 2,200 | 500 | e 7,535 |
| New York | 748,160 | 565,987 | 795,721 | 557,954 | 911,951 |
| North Carolina | 4,365 | 2,741 | | | |
| Oklahoma | | | | | 16,805 |
| Pennsylvania | 93,200 | 90,390 | 97,887 | 171,632 | 118,539 |
| Tennessee | 485,905 | 505,250 | 582,220 | 635,821 | 688,148 |
| Utah | 3,200 | 3,950 | 1,150 | 1,400 | 2,500 |
| Vermont | 3,011,505 | 4,004,669 | 4,410,820 | 4,576,913 | 4,596,724 |
| Washington | 40,117 | 23,008 | 60,000 | 59,985 | (c) |
| Wyoming | 3,100 | 2,000 | 2,500 | 1,000 | |
| Other States | f 91,300 | g 59,916 | | | |
| Total | 5,362,686 | 6,297,835 | 7,129,071 | 7,582,938 | 7,837,685 |

a Included in "Other States."
b Included in Washington.
c Included in New Mexico.
d Included in limestone.
e Includes Idaho and Washington.
f Includes Alabama, Arizona, Connecticut, Missouri, and New Mexico.
g Includes Alabama, Alaska, Arizona, Arkansas, Connecticut, and Missouri.

The following table shows the various uses to which the marble quarried in 1903, 1904, 1905, 1906, and 1907 was put:

*Distribution and value of output of marble, 1903–1907, among various uses.*

| Use. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|---|
| Sold by producers in rough state | $2,275,429 | $2,454,263 | $2,599,052 | $2,987,542 | $1,795,169 | $1,697,891 |
| Dressed for building | 1,038,302 | 1,111,072 | 988,671 | 1,168,450 | 1,559,925 | 1,905,145 |
| Ornamental purposes | 7,300 | 51,359 | 21,554 | 13,643 | 44,523 | 25,050 |
| Dressed for monumental work | 956,870 | 1,062,339 | 1,211,389 | 1,170,279 | 2,214,872 | 2,044,000 |
| Interior decoration in buildings | 679,913 | 663,553 | 1,257,963 | 1,682,651 | 1,722,445 | 1,900,952 |
| Other uses | 86,368 | 20,100 | 219,206 | 106,506 | 246,004 | 264,647 |
| Total | 5,044,182 | 5,362,686 | 6,297,835 | 7,129,071 | 7,582,938 | 7,837,685 |

## LIMESTONE.

The value of the limestone in this report does not include the value of the stone burned into lime or the value of the lime burned, this being given in a special report on lime. A large quantity of limestone used in the manufacture of Portland cement is also not included in this report, as its value enters into and is included in the value of the cement.

The total limestone output increased in value $4,410,489 in 1907, or from $27,327,142 in 1906 to $31,737,631 in 1907. In 1906 the ncrease over $26,025,210, the value for 1905, was $1,301,932. The large increase in 1907 was in the value of crushed stone, which gained $2,602,188 and in blast furnace flux which gained $1,531,797. Other increases in value were in paving, curbing, rubble, riprap, and in the stone used by sugar factories, paper mills, carbonic-acid plants, alkali works, glass works, and for other miscellaneous purposes. Limestone for building and flagstones decreased in value.

The chief States producing limestone in 1907 were, in order, Pennsylvania, Illinois, Indiana, Ohio, New York, and Missouri, each reporting over $2,000,000. In 1906 the rank of production for these States was Pennsylvania, Indiana, Ohio, Illinois, New York, and Missouri—Illinois becoming second in 1907 in place of Indiana and pushing Ohio to fourth place. The combined output of these six States in 1907 amounted to $21,839,006, or 68.78 per cent of the total; in 1906, these States produced $18,751,122, or 68.62 per cent of the total. The increase for these six States would account for over $3,000,000 of the total limestone increase, but it must be borne in mind, that Indiana did not increase but decreased somewhat in value of output. Other States reporting a value of over $500,000 were Wisconsin, Kentucky, West Virginia, Kansas, Michigan, Minnesota, Alabama, Iowa, and Colorado; in 1906 these States ranked as follows: Wisconsin, Kansas, Kentucky, Michigan, Minnesota, West Virginia, and Alabama.

In 1907 thirty-one States and Territories—Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin—increased in the value of their limestone output; the remaining ten States—Indiana, Kansas, Maine, Maryland, Massachusetts, Montana, North Carolina, Oregon, Tennessee and Wyoming—showed decreases.

States showing notable increases were Alabama, Arizona, California, Colorado, Illinois, Missouri, New York, Ohio, Pennsylvania, West Virginia, and Wisconsin.

The increase in Alabama and Arizona was in value of furnace flux, reports being obtained for the first time from smelting plants in Arizona. In California there was an increase in flux and also in quantity of stone reported as used by sugar factories. The price of California stone was reported as much higher than in previous years on account of conditions of labor and high cost of production occasioned by the earthquake of 1906. The Colorado increase was in value of flux and in more complete returns for stone used in sugar factories. The large gain in Illinois of $832,015 was due to the largely increased demand for crushed stone. This State produced in 1907 18.84 per cent of the total limestone value of crushed stone and 11.68 per cent of the total value of crushed stone for the United States. The increase in New York was in value of crushed stone, furnace flux and stone sold to or used by alkali works, carbonic-acid plants, paper mills, etc. The increase for Ohio was in value of crushed stone, flux, and stone used by or sold to alkali plants, glass works, carbonic-acid plants, etc. The output of Pennsylvania and West Virginia was also increased by the production of more crushed stone than in preceding years.

*Building stone.*—Limestone for building purposes, including rough and dressed stone sold by the producers, was valued at $4,580,226 in

1907, as against $5,098,631 in 1906, a decrease of $518,405. In 1906 the decrease from the 1905 value, $5,312,183, was $213,552.

The rough building stone sold by the quarrymen in 1907 was valued at $2,593,875, the dressed stone at $1,986,351; the figures for 1906 were rough stone $2,730,612, dressed stone $2,368,019—a decrease of $136,737 in rough stone and of $381,668 in dressed stone.

Indiana with an output of building stone valued at $2,378,008 produced 51.92 per cent of the total building limestone in 1907; in 1906 the output was $2,636,421, or 51.71 per cent of the total—a decrease in 1907 of $258,413 for the State. This building stone is quarried principally in Lawrence and Monroe counties and is universally known as "Bedford limestone," from the town of Bedford, Lawrence County, the shipping center for a large quantity of the stone. Although used chiefly for building purposes some of this stone is sold for flagging curbing, monumental stone, crushed stone, furnace flux, and a quantity—not included in this report—for making cement and lime. The total value of the output from Lawrence County in 1907 was $1,413,280; from Monroe County, $908,612, a total of $2,321,892 for the two counties; in 1906 the total for the two counties was $2,622,805, with a value of $1,460,743 for Lawrence County and of $1,162,062 for Monroe County, a decrease of $300,913 in the total for 1907 of $253,450 for Monroe County and of $47,463 for Lawrence County. The total product of these counties in 1907 was 7,849,027 cubic feet of stone, of which 4,930,055 cubic feet were sold rough and 2,918,972 cubic feet as sawed or cut stone. In 1906 the total quantity was 9,282,004 cubic feet, of which 5,586,282 cubic feet were rough stone and 3,695,722 cubic feet were cut or sawed stone. These figures for 1907 do not include 256,960 tons, valued at $110,525, sold for rubble, riprap, crushed stone, flux, etc. The decrease in both quantity and value of output accords with the statements of the quarrymen, who reported less demand during 1907, especially the last half, than in 1906. The average price per cubic foot, including rough and sawed stone, was 30 cents in 1907; in 1906 it was 28 cents.

Missouri ranked next to Indiana in the production of building limestone, the value of the output for 1907 being $538,114 as against $690,625, a decrease of $152,511. This stone is principally from Carthage, Jasper County.

*Paving.*—Limestone used for paving increased slightly in 1907, from $531,275 in 1906 to $545,300 in 1907, an increase of $14,025. Illinois and Pennsylvania supplied the largest part of this material.

*Curbing.*—Limestone for curbing increased in value from $289,615 in 1906 of $378,853 in 1907, a gain of $89,238. Indiana gave the largest output for this class of stone.

*Flagging.*—Flagging decreased in value from $109,632 in 1906 to $84,076 in 1907, a loss of $25,556. Indiana and Missouri had the largest productions.

*Rubble.*—Limestone for rubble increased from $924,275 in 1906 to $1,067,445 in 1907, a gain of $143,170. Illinois, Missouri, and Minnesota reported the largest productions.

*Riprap.*—Limestone for riprap increased from $550,385 in 1906 to $620,328 in 1907, a gain of $69,943. Missouri, Minnesota, Illinois, and Ohio reported the largest productions.

*Crushed stone.*—The largest item in value of the limestone production is for stone crushed and used for road making, railroad ballast, concrete, etc., which in 1907 was valued at $13,675,453, representing 23,532,897 short tons; in 1906 these figures were 20,286,589 short tons, valued at $11,073,265, an increase in 1907 of 3,246,308 short tons in quantity and of $2,602,188 in value. In 1906 the increase over 1905, when the output was reported as 19,334,168 short tons, valued at $10,487,638, was 952,421 short tons in quantity and $585,627 in value.

In 1907 the total was divided into 9,619,178 short tons, valued at $5,860,977, for road making; 8,122,342 tons, valued at $4,144,345, for railroad ballast, and 5,791,377 tons, valued at $3,670,131, for concrete, which, compared with the itemized output for 1906—road making, 6,685,781 tons, valued at $3,857,500; railroad ballast, 8,106,850 tons, valued at $3,899,396; concrete, 5,493,958 tons, valued at $3,316,369—shows an increase of 2,933,397 tons in quantity and of $2,003,477 in value for road making, 15,492 tons and $244,949 for railroad ballast, and 297,419 tons and $353,762 for concrete.

It is possible that the large increase in crushed stone for road making contains some stone used for concrete, many of the operators reporting that they were unable to subdivide, except approximately, their total output of crushed stone, not knowing the exact use which was to be made of the stone. The average price per short ton in 1907 was 58 cents compared with 55 cents in 1906.

Illinois ranked first in 1907 in the production of crushed limestone, followed by Ohio, New York, Pennsylvania, Missouri, Indiana, Kentucky, Wisconsin, and Kansas in the order named. These nine States, each reporting values ranging from $2,576,155 to $489,709, represented 83.46 per cent of the total value of crushed limestone. Ohio, Illinois, and New York had the largest output for road making, Pennsylvania, Illinois, and New York for railroad ballast, and Illinois, New York, Missouri, and Pennsylvania for concrete.

*Furnace flux.*—Next to crushed stone the largest production of limestone is that for furnace flux, which was valued at $9,144,489 in 1907 as against $7,612,692 in 1906, an increase of $1,531,797 for 1907. These figures represent outputs of 17,119,297 long tons in 1907 and 16,077,202 long tons in 1906, a gain in 1907 of 1,042,095 long tons. The average value per ton increased from 47 cents in 1906 to 53 cents in 1907. Pennsylvania, Ohio, Alabama, and West Virginia are the ranking States, Pennsylvania producing 41.88 per cent of the total quantity. Most producers report increased prices per ton due to increased cost of production. This was especially true in California. In Indiana for perhaps the first time a quantity of the waste stone from the quarries in the Bedford-Bloomington district was utilized as furnace flux, it being sold at a very low price loaded on cars for shipment, mostly to Chicago.

Quantities of stone used or sold in many States for the purpose of sugar refining have warranted a separation of this stone from other chemical industries.

*Other purposes.*—This heading includes stone quarried and used by alkali works in New York and Michigan in the manufacture of all kinds of alkaline salts; stone sold to glass factories in Pennsylvania, Ohio, Missouri, Indiana, Illinois, and New York; also stone sold to paper mills, to farmers for burning into lime to be used as a fertilizer, and to carbonic-acid plants. It also includes some stone sold for the making of whiting, mineral wool, and for many minor uses.

The following table shows the value of limestone produced in the United States in 1906 and 1907 by States and Territories and uses:

*Value of the production of limestone in the United States in 1906 and 1907, by States and Territories and uses.*

### 1906.

| State or Territory. | Rough building. | Dressed building. | Paving. | Curbing. | Flagging. | Rubble. | Riprap. |
|---|---|---|---|---|---|---|---|
| Alabama | $200 | $22,394 | | | | | $67,028 |
| Arizona | 40 | | | | | | |
| Arkansas | 7,561 | 37,612 | | | | $621 | |
| California | 8,985 | | $200 | $5,000 | | 2,500 | |
| Colorado | | | | | | 3,153 | |
| Connecticut | | | | | | | |
| Florida | 300 | 1,050 | | | | | |
| Georgia | 2,840 | | 350 | | | 670 | |
| Idaho | | | | | | | |
| Illinois | 105,410 | 25,341 | 176,646 | 3,556 | $7,775 | 378,582 | 48,823 |
| Indiana | 1,169,762 | 1,466,659 | 6,731 | 174,135 | 24,798 | 24,254 | 10,780 |
| Indian Territory | 500 | 500 | | | | 3,622 | |
| Iowa | 105,203 | 31,350 | 6,527 | 8,030 | 7,632 | 84,553 | 35,810 |
| Kansas | 95,009 | 36,528 | 17,492 | 14,081 | 4,878 | 34,351 | 18,494 |
| Kentucky | 116,164 | 93,675 | 760 | 15,387 | 1,123 | 6,864 | 22,353 |
| Maine | | | | | | | |
| Maryland | 8,393 | | 44 | 20 | 715 | | |
| Massachusetts | 775 | | | | | | |
| Michigan | 9,368 | 641 | 90,723 | 75 | | 4,654 | 1,204 |
| Minnesota | 124,651 | 132,385 | 4.629 | 4,867 | 11,696 | 112,565 | 51,476 |
| Missouri | 302,627 | 387,998 | 9,100 | 8,516 | 24,732 | 128,430 | 101,755 |
| Montana | 5,117 | | 150 | | | 875 | |
| Nebraska | 30,685 | 1,230 | 7,500 | 10,200 | | 11,878 | 20,140 |
| New Jersey | 2,106 | | | | | | |
| New Mexico | 1,800 | | | | | 2,400 | 2,400 |
| New York | 180,627 | 64,595 | 4,100 | 10,648 | 11,229 | 12,692 | 13,453 |
| North Carolina | | | | | | | |
| Ohio | 155,905 | 7,894 | 1,480 | 1,100 | 478 | 6,395 | 86,215 |
| Oklahoma | 2,350 | 900 | | | 741 | 2,440 | 11,000 |
| Oregon | 3,000 | | | 180 | | | 200 |
| Pennsylvania | 74,625 | 8,728 | 139,643 | 1,453 | 2,309 | 8,480 | 4,029 |
| Rhode Island | | | | | | | |
| South Dakota | 400 | | | | | | |
| Tennessee | 18,597 | 7,400 | | 4,212 | 62 | 11,135 | 7,422 |
| Texas | 38,705 | 10,949 | 32,929 | 407 | | 6,604 | 12,842 |
| Utah | 11,192 | 500 | | | | 1,300 | |
| Vermont | 6,334 | 2,000 | | | | 600 | |
| Virginia | 3,448 | 1,680 | | 275 | | | 323 |
| Washington | 1,200 | | | | | | |
| West Virginia | 461 | | | | | | 745 |
| Wisconsin | 136,272 | 26,010 | 32,271 | 27,473 | 11,464 | 74,307 | 33,893 |
| Wyoming | | | | | | 350 | |
| Total | 2,730,612 | 2,368,019 | 531,275 | 289,615 | 109,632 | 924,275 | 550,385 |

*Value of the production of limestone in the United States in 1906 and 1907 by States and Territories and uses*—Continued.

**1906—Continued.**

| State or Territory. | Crushed stone. |  |  | Flux. | Sugar factories, etc. | Other. | Total. |
|---|---|---|---|---|---|---|---|
|  | Road making. | Railroad ballast. | Concrete. |  |  |  |  |
| Alabama | $9,380 | .......... | $7,280 | $473,062 | .......... | .......... | $579,344 |
| Arizona | .......... | .......... | .......... | .......... | .......... | .......... | 40 |
| Arkansas | 1,600 | $1,000 | 450 | .......... | .......... | .......... | 48,844 |
| California | 4,094 | 500 | 10,962 | 25,000 | $22,964 | .......... | 80,205 |
| Colorado | 3,500 | .......... | .......... | 301,913 | 39,592 | $25,000 | 373,158 |
| Connecticut | .......... | .......... | .......... | 1,171 | .......... | .......... | 1,171 |
| Florida | .......... | .......... | 100 | .......... | .......... | .......... | 1,450 |
| Georgia | .......... | 675 | 1,050 | 10,417 | 40 | .......... | 16,042 |
| Idaho | .......... | .......... | .......... | .......... | 12,600 | .......... | 12,600 |
| Illinois | 686,092 | 389,065 | 709,907 | 384,282 | 17,433 | 9,419 | 2,942,331 |
| Indiana | 321,891 | 169,695 | 119,222 | 210,124 | 9,455 | 18,059 | 3,725,565 |
| Indian Territory | .......... | 20,000 | 20,000 | .......... | .......... | .......... | 44,622 |
| Iowa | 38,189 | 26,268 | 142,124 | .......... | .......... | 8,129 | 493,815 |
| Kansas | 39,877 | 533,173 | 34,228 | .......... | 5 | 21,087 | 849,203 |
| Kentucky | 222,877 | 242,737 | 50,327 | 15,170 | .......... | 7,971 | 795,408 |
| Maine | .......... | .......... | .......... | .......... | 2,000 | .......... | 2,000 |
| Maryland | 30,582 | 110,503 | 19,024 | .......... | 40 | 725 | 170,046 |
| Massachusetts | .......... | .......... | .......... | 9,875 | 100 | .......... | 10,750 |
| Michigan | 78,437 | 103,442 | 61,852 | 81,517 | 224,356 | .......... | 656,269 |
| Minnesota | 50,230 | 8,041 | 117,159 | 150 | 3,625 | 1,641 | 632,115 |
| Missouri | 294,211 | 336,752 | 316,136 | 28,381 | 11,591 | 38,105 | 1,968,334 |
| Montana | .......... | .......... | .......... | 134,940 | .......... | .......... | 141,082 |
| Nebraska | 16,000 | 29,980 | 112,235 | 6,600 | 29,891 | 42 | 276,381 |
| New Jersey | 4,640 | 7,950 | 10,950 | 195,235 | .......... | 260 | 221,141 |
| New Mexico | .......... | 108,893 | 6,000 | .......... | .......... | 4,000 | 125,493 |
| New York | 584,261 | 324,940 | 464,614 | 294,659 | 221,192 | 17,714 | 2,204,724 |
| North Carolina | 30,583 | .......... | .......... | .......... | .......... | .......... | 30,583 |
| Ohio | 924,346 | 407,005 | 286,460 | 1,013,497 | 48,806 | 85,457 | 3,025,038 |
| Oklahoma | 9,000 | 90,000 | 7,700 | .......... | .......... | 3,230 | 127,361 |
| Oregon | .......... | .......... | .......... | .......... | 3,600 | 500 | 7,480 |
| Pennsylvania | 251,200 | 602,128 | 486,882 | 3,168,186 | 76,073 | 41,394 | 4,865,130 |
| Rhode Island | .......... | .......... | .......... | 678 | .......... | .......... | 678 |
| South Dakota | .......... | .......... | 10,000 | .......... | .......... | .......... | 10,400 |
| Tennessee | 23,725 | 192,514 | 75,063 | 139,227 | .......... | 2,595 | 481,952 |
| Texas | 3,250 | 23,000 | 30,685 | 75,764 | .......... | 3,990 | 239,125 |
| Utah | 13,030 | .......... | 15 | 198,671 | 23,910 | 250 | 248,868 |
| Vermont | 2,320 | .......... | 2,000 | 250 | .......... | 1,224 | 14,728 |
| Virginia | 160 | 16,050 | 18,700 | 219,707 | .......... | .......... | 260,343 |
| Washington | .......... | .......... | .......... | 38,831 | 8,761 | 400 | 49,192 |
| West Virginia | 17,406 | 67,700 | 20,875 | 513,413 | 6,865 | 1,137 | 628,602 |
| Wisconsin | 187,619 | 86,575 | 173,237 | 71,972 | 7,940 | 22,713 | 891,746 |
| Wyoming | .......... | 810 | 1,132 | .......... | 51,491 | .......... | 53,783 |
| Total | 3,857,500 | 3,899,396 | 3,316,369 | 7,612,692 | 822,330 | 315,042 | 27,327,142 |

*Value of the production of limestone in the United States in 1906 and 1907, by States and Territories and uses*—Continued.

### 1907.

| State or Territory. | Rough building. | Dressed building. | Paving. | Curbing. | Flagging. | Rubble. | Riprap. |
|---|---|---|---|---|---|---|---|
| Alabama | $5,200 | $12,375 | $11,100 | ... | ... | $11,113 | $23,970 |
| Arizona | 200 | ... | ... | ... | ... | ... | ... |
| Arkansas | 10,373 | 33,069 | ... | ... | ... | 3,157 | ... |
| California | 9,400 | ... | ... | ... | ... | 225 | ... |
| Colorado | ... | ... | ... | ... | ... | ... | ... |
| Connecticut | ... | ... | ... | ... | ... | ... | ... |
| Florida | ... | ... | ... | ... | ... | ... | ... |
| Georgia | 1,860 | 500 | ... | $200 | ... | 245 | ... |
| Idaho | ... | ... | ... | ... | ... | ... | ... |
| Illinois | 83,408 | 26,022 | 150,193 | 12,031 | $5,916 | 363,045 | 77,627 |
| Indiana | 1,168,476 | 1,209,532 | 3,202 | 204,750 | 21,432 | 20,188 | 12,980 |
| Iowa | 108,992 | 34,663 | 23,411 | 1,345 | 3,682 | 72,232 | 46,146 |
| Kansas | 92,206 | 49,172 | 53,885 | 51,663 | 4,052 | 42,613 | 18,078 |
| Kentucky | 106,293 | 71,938 | 3,515 | 23,555 | 1,663 | 2,467 | 8,730 |
| Maine | ... | ... | ... | ... | ... | ... | ... |
| Maryland | 2,100 | ... | 1,767 | 20 | 150 | ... | 50 |
| Massachusetts | 100 | ... | ... | ... | ... | ... | ... |
| Michigan | 15,120 | 100 | 56,500 | ... | ... | 1,433 | 1,234 |
| Minnesota | 151,985 | 112,993 | 3,065 | 4,264 | 8,267 | 109,928 | 98,529 |
| Missouri | 205,436 | 332,678 | 2,218 | 14,104 | 12,699 | 218,827 | 152,090 |
| Montana | 6,160 | ... | ... | ... | ... | ... | ... |
| Nebraska | 21,050 | 29 | ... | ... | ... | 16,983 | 17,833 |
| New Jersey | 700 | ... | ... | ... | ... | ... | ... |
| New Mexico | 300 | ... | 180 | ... | ... | ... | ... |
| New York | 176,746 | 41,202 | 25,304 | 14,869 | 6,630 | 21,453 | 8,380 |
| North Carolina | 13,328 | ... | ... | ... | ... | ... | ... |
| Ohio | 114,250 | 4,495 | 17,027 | 2,228 | 440 | 70,851 | 63,434 |
| Oklahoma | 4,105 | 2,175 | 9,000 | 7,855 | 877 | 2,663 | 19,566 |
| Oregon | 3,000 | 500 | ... | 100 | ... | ... | 600 |
| Pennsylvania | 113,919 | 2,315 | 143,013 | 2,272 | 6,820 | 27,805 | 11,220 |
| Rhode Island | ... | ... | ... | ... | ... | ... | ... |
| South Dakota | 1,100 | ... | ... | ... | ... | ... | ... |
| Tennessee | 9,275 | 9,497 | 2,672 | 3,542 | 30 | 11,100 | 4,018 |
| Texas | 31,295 | 1,948 | 8,388 | 1,075 | ... | 32,150 | 21,650 |
| Utah | 10,855 | 445 | ... | ... | ... | ... | 475 |
| Vermont | 9,598 | 364 | ... | 107 | ... | 850 | ... |
| Virginia | 3,170 | 1,130 | 500 | ... | ... | ... | ... |
| Washington | ... | ... | ... | ... | ... | ... | ... |
| West Virginia | 420 | ... | ... | ... | ... | ... | ... |
| Wisconsin | 110,955 | 39,209 | 30,360 | 34,873 | 11,418 | 38,117 | 33,718 |
| Wyoming | 2,500 | ... | ... | ... | ... | ... | ... |
| Total | 2,593,875 | 1,986,351 | 545,300 | 378,853 | 84,076 | 1,067,445 | 620,328 |

*Value of the production of limestone in the United States in 1906 and 1907, by States and Territories and uses*—Continued.

**1907—Continued.**

| State or Territory. | Crushed stone. | | | Flux. | Sugar factories. | Other. | Total. |
|---|---|---|---|---|---|---|---|
| | Road making. | Railroad ballast. | Concrete. | | | | |
| Alabama | $5,000 | | $21,287 | $604,654 | | | $604,699 |
| Arizona | | | | 64,775 | | | 64,975 |
| Arkansas | 608 | $5,000 | | | | | 52,207 |
| California | 6,375 | 1,800 | 18,290 | 48,376 | $88,116 | $4,751 | 177,333 |
| Colorado | | | 2,620 | 397,244 | 102,887 | | 502,751 |
| Connecticut | | | | 1,476 | | | 1,476 |
| Florida | 15,000 | | | | | | 15,000 |
| Georgia | 407 | 550 | 155 | 18,080 | | 281 | 22,278 |
| Idaho | | | | 6,900 | 9,000 | | 15,900 |
| Illinois | 958,032 | 499,204 | 1,118,919 | 423,315 | 8,151 | 48,483 | 3,774,346 |
| Indiana | 476,711 | 134,932 | 60,918 | 279,838 | | 31,667 | 3,624,126 |
| Iowa | 69,817 | 77,571 | 118,682 | | | 4,041 | 560,582 |
| Kansas | 76,420 | 357,820 | 55,469 | 50 | | 12,320 | 813,748 |
| Kentucky | 290,669 | 292,714 | 53,787 | 14,489 | | 21,680 | 891,500 |
| Maine | | | | | | 1,350 | 1,350 |
| Maryland | 66,565 | 61,881 | 8,842 | | | 1,450 | 142,825 |
| Massachusetts | | | | 1,737 | | | 1,837 |
| Michigan | 131,708 | 46,516 | 97,762 | 109,429 | 22,234 | 278,297 | 760,333 |
| Minnesota | 116,143 | 22,398 | 103,854 | 119 | 2,675 | 1,099 | 735,319 |
| Missouri | 428,261 | 284,058 | 418,990 | 43,612 | 317 | 40,627 | 2,153,917 |
| Montana | | | | 118,080 | 450 | | 124,690 |
| Nebraska | 55,824 | 53,584 | 120,977 | 11,700 | 13,635 | 1,015 | 312,603 |
| New Jersey | 3,545 | 3,000 | 3,830 | 262,873 | | 504 | 274,452 |
| New Mexico | | 175,252 | | | 18,000 | | 193,732 |
| New York | 956,535 | 440,223 | 450,799 | 343,866 | | 412,513 | 2,898,520 |
| North Carolina | 9,000 | | | | | | 22,328 |
| Ohio | 1,232,939 | 393,453 | 285,159 | 1,134,793 | 4,800 | 242,953 | 3,566,822 |
| Oklahoma | 4,000 | 120,747 | 15,205 | | | 3,375 | 189,568 |
| Oregon | | | | | 1,375 | 175 | 5,750 |
| Pennsylvania | 445,347 | 676,776 | 412,451 | 3,829,967 | | 149,370 | 5,821,275 |
| Rhode Island | | | | 750 | | | 750 |
| South Dakota | | | 10,500 | | | | 11,600 |
| Tennessee | 13,900 | 118,911 | 41,530 | 169,775 | | 1,200 | 385,450 |
| Texas | 48,318 | 57,993 | 3,748 | 59,394 | | 1,798 | 267,757 |
| Utah | | | | 266,789 | 27,600 | 180 | 306,344 |
| Vermont | 5,257 | | 4,850 | 535 | | 1,565 | 23,126 |
| Virginia | 37,000 | 12,269 | 32,326 | 275,517 | | 150 | 362,062 |
| Washington | | | | 53,868 | 1,200 | 7,249 | 62,317 |
| West Virginia | 18,166 | 271,667 | 21,167 | 528,587 | | 15,934 | 855,941 |
| Wisconsin | 389,430 | 36,026 | 188,014 | 73,901 | | 41,074 | 1,027,095 |
| Wyoming | | | | | 16,420 | | 18,920 |
| Total | 5,860,977 | 4,144,345 | 3,670,131 | 9,144,489 | 316,860 | 1,324,601 | 31,737,631 |

The following table shows the value of limestone, by States, from 1903 to 1907, inclusive:

*Value of limestone, 1903–1907, by States and Territories.*

| State or Territory. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Alabama | $502,510 | $498,723 | $532,103 | $579,344 | $694,699 |
| Arizona | | 250 | 135 | 40 | 64,975 |
| Arkansas | 153,291 | 106,147 | 154,818 | 48,844 | 52,207 |
| California | 229,376 | 74,670 | 49,902 | 80,205 | 177,333 |
| Colorado | 175,078 | 124,600 | 289,920 | 373,158 | 502,751 |
| Connecticut | 1,968 | 830 | 1,558 | 1,171 | 1,476 |
| Florida | 20,756 | 34,278 | 5,800 | 1,450 | 15,000 |
| Georgia | 10,450 | 15,200 | 9,030 | 16,042 | 22,278 |
| Idaho | 752 | 5,900 | 14,105 | 12,600 | 15,900 |
| Illinois | 2,726,470 | 2,690,822 | 3,511,890 | 2,942,331 | 3,774,346 |
| Indiana | 2,621,068 | 2,789,500 | 3,189,259 | 3,725,565 | 3,624,126 |
| Indian Territory | 650 | 6,076 | 5,512 | 44,622 | |
| Iowa | 536,906 | 442,585 | 451,791 | 493,815 | 560,582 |
| Kansas | 480,609 | 799,286 | 923,389 | 849,203 | 813,748 |
| Kentucky | 695,602 | 692,417 | 744,465 | 795,408 | 891,500 |
| Maine | 1,863 | 2,955 | 7,428 | 2,000 | 1,350 |
| Maryland | 65,732 | 128,421 | 149,402 | 170,046 | 142,825 |
| Massachusetts | 9,656 | 7,566 | 65,908 | 10,750 | 1,837 |
| Michigan | 390,473 | 501,708 | 544,754 | 656,269 | 760,333 |
| Minnesota | 609,471 | 517,940 | 555,401 | 632,115 | 735,319 |
| Missouri | 1,874,740 | 2,277,969 | 2,238,164 | 1,988,334 | 2,153,917 |
| Montana | 131,594 | 109,765 | 103,123 | 141,082 | 124,690 |
| Nebraska | 187,718 | 236,780 | 225,119 | 276,381 | 312,630 |
| New Jersey | 66,915 | 76,710 | 147,353 | 221,141 | 274,452 |
| New Mexico | | | 7,200 | 125,493 | 193,732 |
| New York | 2,007,911 | 1,636,255 | 1,970,968 | 2,204,724 | 2,898,520 |
| North Carolina | | 12,088 | 16,500 | 30,583 | 22,328 |
| Ohio | 2,349,661 | 2,406,355 | 2,850,793 | 3,025,038 | 3,566,822 |
| Oklahoma | 50,690 | 92,246 | 163,412 | 127,361 | 189,568 |
| Oregon | 3,000 | 5,390 | 8,600 | 7,480 | 5,750 |
| Pennsylvania | 4,343,643 | 3,708,750 | 4,490,503 | 4,865,130 | 5,821,275 |
| Rhode Island | 883 | 312 | 300 | 678 | 750 |
| South Carolina | 950 | 225 | | | |
| South Dakota | 26,215 | 3,954 | 6,653 | 10,400 | 11,600 |
| Tennessee | 356,961 | 288,053 | 401,622 | 481,952 | 385,450 |
| Texas | 188,015 | 252,745 | 171,847 | 239,125 | 267,757 |
| Utah | 125,610 | 170,447 | 232,519 | 248,868 | 306,344 |
| Vermont | 9,955 | 9,653 | 11,095 | 14,728 | 23,126 |
| Virginia | 232,744 | 165,459 | 212,660 | 260,343 | 362,062 |
| Washington | 75,649 | 71,857 | 52,470 | 49,192 | 62,317 |
| West Virginia | 405,077 | 460,303 | 671,318 | 628,602 | 855,941 |
| Wisconsin | 701,347 | 738,684 | 804,081 | 891,746 | 1,027,095 |
| Wyoming | 150 | 15,090 | 23,340 | 53,783 | 18,920 |
| Total | 22,372,109 | 22,178,964 | 26,025,210 | 27,327,142 | 31,737,631 |

The following table shows the production of limestone for furnace flux in 1906 and 1907, by States, in long tons:

*Production of furnace flux in 1906 and 1907, by States, in long tons.*

| State or Territory. | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Alabama | 803,643 | $473,062 | 939,437 | $604,654 |
| Arizona | | | 115,714 | 64,775 |
| California | 28,758 | 25,000 | 38,225 | 48,376 |
| Colorado | 552,651 | 301,913 | 672,801 | 397,244 |
| Connecticut | 3,455 | 1,171 | 3,735 | 1,476 |
| Georgia | 17,793 | 10,417 | 30,825 | 18,080 |
| Idaho | | | 4,100 | 6,900 |
| Illinois | 909,375 | 384,282 | 970,158 | 423,315 |
| Indiana | 500,702 | 210,124 | 577,052 | 279,838 |
| Kansas | | | 50 | 50 |
| Kentucky | 33,987 | 15,170 | 31,752 | 14,489 |
| Massachusetts | 16,528 | 9,875 | 3,560 | 1,737 |
| Michigan | 162,603 | 81,517 | 128,926 | 109,429 |
| Minnesota | 200 | 150 | 135 | 119 |
| Missouri | 43,574 | 28,381 | 55,371 | 43,612 |
| Montana | 304,600 | 134,940 | 236,200 | 118,080 |
| Nebraska | 12,000 | 6,600 | 18,000 | 11,700 |
| New Jersey | 363,508 | 195,235 | 465,018 | 262,873 |
| New York | 513,452 | 294,659 | 584,964 | 343,866 |
| Ohio | 3,098,346 | 1,013,497 | 2,497,616 | 1,134,793 |
| Pennsylvania | 6,396,765 | 3,168,186 | 7,178,508 | 3,829,967 |
| Rhode Island | 542 | 678 | 500 | 750 |
| Tennessee | 250,835 | 139,227 | 299,247 | 169,775 |
| Texas | 122,804 | 75,764 | 93,531 | 59,394 |
| Utah | 262,808 | 198,671 | 372,896 | 266,789 |
| Vermont | 500 | 250 | 535 | 535 |
| Virginia | 467,341 | 219,707 | 541,610 | 275,517 |
| Washington | 41,171 | 38,831 | 80,295 | 53,868 |
| West Virginia | 1,019,931 | 513,413 | 1,063,772 | 528,587 |
| Wisconsin | 149,330 | 71,972 | 114,764 | 73,901 |
| Total | 16,077,202 | 7,612,692 | 17,119,297 | 9,144,489 |
| Average price per ton | | .47 | | .53 |

# ABRASIVE MATERIALS.

By W. C. PHALEN.

## INTRODUCTION.

The abrasive materials included in this report are millstones and buhrstones, grindstones and pulpstones, oilstones and scythestones, corundum and emery, abrasive quartz and abrasive feldspar, garnet, infusorial earth and tripoli, pumice, and the artificial abrasives which include carborundum, alundum, and crushed steel. Of some of these materials only a small part of the entire product is actually used for abrasive purposes. In this report, so far as it has been possible, there is included, with the exception of tripoli and possibly infusorial earth, only that part of the product that is actually used for abrasive purposes. Thus under grindstones and pulpstones, which are obtained from sandstone, only a small percentage of the stone that is quarried is used in the manufacture of abrasives, the remainder being used chiefly in the building industry; also, as stated on another page, only a small proportion of the crystalline quartz and feldspar produced is used in the abrasive industry. A large part of the tripoli mined in Missouri is used in the filter stone industry. Practically all the raw material mined or quarried for millstones, pumice, corundum, emery, and garnet (except the gem garnet) is used for abrasive purposes.

Fairly detailed descriptions of the occurrence and mode of preparation of the different abrasive materials have appeared in preceding reports of the United States Geological Survey. Thus oilstones and whetstones were described in the report for 1901, and grindstones, buhrstones, millstones, infusorial earth and tripoli in the reports for 1900 and 1901. In the report for 1902 the deposits of infusorial earth of Pinal County, Ariz., were described by W. P. Blake.[a] Pumice was treated in the report for 1901, and artificial abrasives in the same report. In the report for 1903 an article on carborundum by F. A. J. Fitzgerald was quoted from the Iron Age,[b] and also an abstract on crushed steel, from the Proceedings of the American Association for the Advancement of Science.[c]

In the present report a detailed description is given of the method of preparing millstones from the Esopus conglomerate in Ulster County, N. Y., the center of the millstone industry in that State, and also of the mode of preparing Missouri tripoli for use in filter stones. The garnet deposits in New York are treated at considerable length, as well as the occurrence of pumice in the central Western States. A detailed description of the manufacture and technology of alundum, among the artificial abrasives, is also given. It is planned to treat the other abrasive materials in similar manner in the next report.

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[a] Am. Inst. Min. Eng., February meeting, 1902.

[b] Iron Age, October 15, 1903.

[c] Proc. Am. Assoc. Adv. Sci., Pittsburg meeting, 1903.

The following table gives the value of all the natural abrasive materials produced in the United States during the years 1903 to 1907, inclusive. The value of the production in 1907 showed a substantial increase as compared with that of 1906. There was a decrease in the value of millstones, oilstones and scythestones, and emery, but an increase in the value of grindstones and pulpstones, abrasive quartz and feldspar, garnet, infusorial earth and tripoli, and pumice. The most apparent reasons for the decrease in the value of millstones are competition and the introduction of modern machinery in grinding. In the case of emery care has been taken that the values assigned have been those of the crude material on board cars at the point of shipment, for only in this way is it possible to assign a uniform value per ton. This, moreover, explains in part why the value of the material is so much less than it has been in preceding years, another reason being the nonproduction of corundum, which in previous years has been combined with emery.

*Value of natural abrasives produced in the United States, 1903–1907.*

| Kind of abrasive. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Oilstones and scythestones | $366,857 | $188,985 | $244,546 | $268,070 | $264,188 |
| Grindstones and pulpstones | 721,446 | 881,527 | 777,606 | 744,894 | 896,022 |
| Buhrstones and millstones | 52,552 | 37,338 | 37,974 | 48,590 | 31,741 |
| Pumice | 2,665 | 5,421 | 5,540 | 16,750 | 33,818 |
| Infusorial earth and tripoli | 76,273 | 44,164 | 64,637 | 72,108 | 104,406 |
| Abrasive quartz | 76,908 | [a] 74,850 | [a] 88,118 | [a] 121,671 | [a] 126,582 |
| Garnet | 132,500 | 117,581 | 148,095 | 157,000 | 211,686 |
| Corundum and emery | 64,102 | 57,235 | 61,464 | 44,310 | 12,294 |
| Total | 1,493,303 | 1,407,101 | 1,427,980 | 1,473,393 | 1,680,737 |

[a] Including feldspar used for abrasive purposes.

Natural abrasives were produced in 23 States in 1907, as compared with 25 States in 1906. The list of States follows, together with the material produced by each:

*List of States producing abrasives in 1907.*

ARKANSAS: Oilstones.
CALIFORNIA: Infusorial earth.
CONNECTICUT: Quartz, feldspar, and infusorial earth.
ILLINOIS: Tripoli.
INDIANA: Oilstones.
KENTUCKY: Infusorial earth.
MARYLAND: Quartz and infusorial earth.
MASSACHUSETTS: Quartz, infusorial earth, and emery.
MICHIGAN: Grindstones and scythestones.
MINNESOTA: Feldspar.
MISSOURI: Tripoli and grindstones.
MONTANA: Grindstones.
NEBRASKA: Pumice.
NEVADA: Infusorial earth.
NEW HAMPSHIRE: Scythestones.
NEW YORY: Garnet, infusorial earth, millstones, and emery.
NORTH CAROLINA: Garnet and millstones.
OHIO: Grindstones, pulpstones, oilstones, and scythestones.
PENNSYLVANIA: Quartz, garnet, and millstones.
VERMONT: Scythestones.
VIRGINIA: Millstones.
WEST VIRGINIA: Grindstones.
WISCONSIN: Quartz.

Under the head of artificial abrasives are included alundum, carborundum, and crushed steel. The production of these substances in the last four years is given in the following table:

*Production and value of artificial abrasives in the United States, 1904–1907.*

| Year. | Quantity, in pounds. | Value. | Year. | Quantity, in pounds. | Value. |
|---|---|---|---|---|---|
| 1904 | 11,870,380 | $830,926 | 1906 | 11,774,300 | $777,081 |
| 1905 | 9,820,000 | 701,400 | 1907 | 14,632,000 | 1,027,246 |

The production of artificial abrasives in 1907 was greater than that of any previous year of which the Survey has record, exceeding that of 1906 by 2,857,700 pounds in quantity and by $250,165 in value.

The total estimated value of all abrasive materials consumed in the United States for the years 1903 to 1907, inclusive, is given in the following table. There was an increase in 1907 in the value of natural abrasives of $207,344 and in the artificial abrasives of $250,165, a total of nearly a half million dollars. There was a decrease in the value of the imports of natural abrasives of $155,824, making a net increase in the domestic consumption of abrasives of all kinds for the year of $301,685, as compared with an increase of $376,437 in 1906. The condition of the domestic industry, however, as appears from the preceding table was much better in 1907 than in any previous year.

*Total value of all abrasive materials consumed in the United States, 1903–1907.*

| Year. | Natural abrasives. | Artificial abrasives. | Imports. | Total value. |
|---|---|---|---|---|
| 1903 | $1,493,303 | $493,815 | $621,575 | $2,608,693 |
| 1904 | 1,407,101 | 830,926 | 547,804 | 2,785,831 |
| 1905 | 1,427,980 | 701,400 | 654,821 | 2,784,001 |
| 1906 | 1,473,393 | 777,081 | 909,964 | 3,160,438 |
| 1907 | 1,680,737 | 1,027,246 | 754,140 | 3,462,123 |

## BUHRSTONES AND MILLSTONES.

### PRODUCTION.

The production of buhrstones and millstones in the United States during 1907 was valued at $31,741. This is a considerable falling off from the values reported to the Survey during the last few years, and the present condition of the industry approximates that of about eight years ago.

The market for millstones has been greatly curtailed of late years. The table given on a subsequent page shows that recently the industry has dwindled very much and that the value for 1907 is less than one-third of the value for 1887. The explanation of this falling off in the millstone industry is due to the introduction of superior forms of grinding machinery, chiefly rolls, ball mills, etc. The roller-mill process of grinding is now used almost exclusively in grinding wheat. Some corn and mustard mills in the Southern States still use hand-made millstones. A part of the product is sold to the cement and talc manufacturers and grinders of mineral paint.

The production of millstones, as usual, came from but four States, namely, New York, North Carolina, Pennsylvania, and Virginia. Though stone suitable for buhrstones and millstones is found in other States, there was no production from them reported to this office.

*Millstone industry in New York.*—New York has led for many years in the production of millstones and chasers, the latter term being applied to stones which run on edge. The raw material is obtained in Ulster County, southeastern New York, and is known as Esopus stone, Esopus being an early name for Kingston, which was formerly the main point of shipment. The material suitable for millstones is quarried from the Shawangunk grit, a quartz conglomerate found near the western base of Shawangunk Mountain in the valley of Rondout River. The material suitable for millstones is exceedingly limited, being confined in linear extent to a strip extending from High Falls on the north to Kerhonkson on the south, a distance of approximately 10 miles. Beyond these limits the texture and other properties of the rock have been found unsuitable for the highest grade of stones.

The methods employed in quarrying the rock are simple. The rock is pried or split out, advantage being taken of the joint planes, especially the concentric surface joints. The tools used are the ordinary hand drill, together with plugs and feathers. Blasting is often resorted to, but the charges of powder are usually light. The rough stones thus obtained are quarry dressed and finished, these operations being performed entirely by hand, the chief tools employed being the bull point and hammer. The operation of drilling the "eye" is performed by centering the stone and then drilling from the center of both faces inward. In many stones the eye is square. To fashion a square eye, a round eye is first drilled out and then squared up. A few of the men engaged in the industry make a modification of the regular millstone for use in the grinding of paint. In this modification the ordinary millstone is cut in halves and an iron casting is placed between the halves, which are then banded together by an iron band.

Chasers are larger than the regular millstones. They are used for heavier work, as in grinding quartz, feldspar, barytes, etc., and, as already mentioned, they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches and with thicknesses as great as 22 inches. These chasers are run on pans paved with blocks of Esopus grit, which are usually roughly cubical with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks the material placed in the pan is ground to powder.

In the following table are given the values by States of buhrstones and millstones produced in the United States from 1903 to 1907:

*Value of buhrstones produced in the United States, 1903–1907, by States.*

| State. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| New York | $35,441 | $24,585 | $25,915 | $28,848 | $23,072 |
| Virginia | 9,812 | 4,759 | 8,186 | 15,611 | 4,684 |
| North Carolina and Vermont | 5,902 | [a] 6,500 | [a] 2,522 | [a] 1,507 | [a] 1,969 |
| Pennsylvania | 1,397 | 1,494 | 1,351 | 2,624 | 2,016 |
| Total | 52,552 | 37,338 | 37,974 | 48,590 | 31,741 |

[a] No production of buhrstones from Vermont in 1904, 1905, 1906, and 1907.

The following table gives the value of millstones and buhrstones produced in the United States since 1880:

*Value of buhrstones and millstones produced in the United States, 1880–1907.*

| | |
|---|---|
| 1880 | $200,000 |
| 1881 | 150,000 |
| 1882 | 200,000 |
| 1883 | 150,000 |
| 1884 | 150,000 |
| 1885 | 100,000 |
| 1886 | 140,000 |
| 1887 | 100,000 |
| 1888 | 81,000 |
| 1889 | 35,155 |
| 1890 | 23,720 |
| 1891 | 16,587 |
| 1892 | 23,417 |
| 1893 | 16,639 |
| 1894 | $13,887 |
| 1895 | 22,542 |
| 1896 | 22,567 |
| 1897 | 25,932 |
| 1898 | 25,934 |
| 1899 | 28,115 |
| 1900 | 32,858 |
| 1901 | 57,179 |
| 1902 | 59,808 |
| 1903 | 52,552 |
| 1904 | 37,338 |
| 1905 | 37,974 |
| 1906 | 48,590 |
| 1907 | 31,741 |

## IMPORTS.

The value of the imports of buhrstones and millstones into the United States during 1907 was the lowest recorded in five years. This marked diminution was in the value of the rough material, as the value of the imports made up into millstones showed a gain. This latter value, however, is still insignificant. The table showing the value of imports from 1903 to 1907 follows:

*Value of buhrstones and millstones imported into the United States, 1903–1907.*

| Year. | Rough. | Made into millstones. | Total. |
|---|---|---|---|
| 1903 | $21,160 | $8,481 | $29,641 |
| 1904 | 30,117 | 2,269 | 32,386 |
| 1905 | 30,478 | 938 | 31,416 |
| 1906 | $32,921 | $277 | $33,198 |
| 1907 | 26,431 | 877 | 27,308 |

## GRINDSTONES AND PULPSTONES.

### PRODUCTION.

The value of the production of grindstones and pulpstones during 1907 amounted to $896,022—an increase in value of $151,128 over that of 1906. This is the highest value recorded by the Survey for grindstones and pulpstones, exceeding by $14,495 the valuation of the year 1904, hitherto the maximum. The production came from the following States named in the order of their relative importance: Ohio, Michigan, West Virginia, Montana, and Missouri, the exact order of importance for 1906. Wyoming reported no production for 1907. In the following table is given the value of the production of grindstones and pulpstones during the last five years:

*Value of the production of grindstones and pulpstones, 1903–1907.*

| | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Grindstones | $687,476 | $820,207 | $726,536 | $694,894 | $846,522 |
| Pulpstones | 33,970 | 61,320 | 51,070 | 50,000 | 49,500 |
| Total | 721,446 | 881,527 | 777,606 | 744,894 | 896,022 |

In the following table are given the values of the grindstones and pulpstones produced in the United States from 1903 to 1907, by States:

*Value of grindstones and pulpstones produced in the United States, 1903–1907, by States.*

| State. | 1903. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|---|
| Ohio | $646,776 | $767,552 | $644,315 | $644,720 | $764,276 |
| Michigan | 70,550 | 112,500 | 111,500 | 78,500 | (a) |
| West Virginia, Missouri, and Montana | 4,120 | [b] 1,475 | [b] 21,791 | [b] 21,674 | 131,746 |
| Total | 721,446 | 881,527 | 777,606 | 744,894 | 896,022 |

[a] Included with West Virginia, etc.
[b] Including a small production from Wyoming in 1904, 1905, and 1906.

The value of the production of grindstones and pulpstones from 1880 to 1907 is shown in the following table:

*Value of grindstones and pulpstones produced in the United States, 1880–1907.*

| Year | Value | Year | Value |
|---|---|---|---|
| 1880 | $500,000 | 1894 | $223,214 |
| 1881 | 500,000 | 1895 | 205,768 |
| 1882 | 700,000 | 1896 | 326,826 |
| 1883 | 600,000 | 1897 | 368,058 |
| 1884 | 570,000 | 1898 | 489,769 |
| 1885 | 500,000 | 1899 | 675,586 |
| 1886 | 250,000 | 1900 | 710,026 |
| 1887 | 224,400 | 1901 | 580,703 |
| 1888 | 281,800 | 1902 | 667,431 |
| 1889 | 439,587 | 1903 | 721,446 |
| 1890 | 450,000 | 1904 | 881,527 |
| 1891 | 476,113 | 1905 | 777,606 |
| 1892 | 272,244 | 1906 | 744,894 |
| 1893 | 338,787 | 1907 | 896,022 |

## IMPORTS.

The imports consist principally of pulpstones and a few grindstones for use in the glass and optical trades. This material is obtained chiefly from Newcastle-upon-Tyne and from Wales and Scotland. The value of imports in 1907 was $111,495, as compared with $134,136 in 1906. No distinction has been made between finished and unfinished products since 1883. The value of the imports of pulpstones and grindstones has shown a steady increase up to 1907, when there was a decided falling off. The figures for the last five years are given in the following table:

*Value of grindstones imported and entered for consumption in the United States, 1903–1907.*

| Year | Value | Year | Value |
|---|---|---|---|
| 1903 | $85,705 | 1906 | $134,136 |
| 1904 | 93,152 | 1907 | 111,495 |
| 1905 | 113,752 | | |

## CANADIAN PRODUCTION.

The value of the production of grindstones in Canada during 1907 amounted to $46,876, as compared with $61,624 in 1906. In the table following is given the value of the Canadian production of grindstones during the last five years.

*Value of production of grindstones in Canada, 1903–1907.*

| | | | |
|---|---|---|---|
| 1903 | $48,302 | 1906 | $61,624 |
| 1904 | 42,782 | 1907 | 46,876 |
| 1905 | 57,200 | | |

## OILSTONES AND SCYTHESTONES.

### PRODUCTION.

The production of oilstones and scythestones in the United States during 1907 amounted to $264,188, as compared with a production of $268,070 in 1906. This is a decrease of $3,882, or but little more than 1.5 per cent; in other words, the condition of the industry for the year is about the same as that for 1906. The production of oilstones and whetstones is from Arkansas, Indiana, and Ohio, and the first State mentioned produces about two-thirds of the output. Scythestones are manufactured from material found in New Hampshire, Vermont, Ohio, and Michigan, named in the order of their relative importance.

In the following table is given the value of the oilstones and scythestones from 1891 to 1907:

*Value of oilstones and scythestones produced in the United States, 1891–1907.*

| | | | |
|---|---|---|---|
| 1891 | $150,000 | 1900 | $174,087 |
| 1892 | 146,730 | 1901 | 158,300 |
| 1893 | 135,173 | 1902 | 221,762 |
| 1894 | 136,873 | 1903 | 366,857 |
| 1895 | 155,881 | 1904 | 188,985 |
| 1896 | 127,098 | 1905 | 244,546 |
| 1897 | 149,970 | 1906 | 268,070 |
| 1898 | 180,486 | 1907 | 264,188 |
| 1899 | 208,283 | | |

### IMPORTS AND EXPORTS.

The value of the imports of hones, oilstones, and whetstones in 1907 amounted to $89,939, as compared with $83,863 in 1906. The imports are a trifle larger in proportion to the domestic production than they were in 1906. In that year they amounted to less than one-third of the home production, but in 1907, owing to the slight increase in imports and the slight decrease in domestic production, the imports are a little more than 33 per cent of the domestic production. The imports are in part offset by the exportation of Arkansas oilstones and New Hampshire scythestones, the value of which, however, can not be given since no separate record is kept of them. The following table shows the total value of all kinds of hones, oilstones, and whetstones imported into the United States in the last five years:

*Value of imports of hones, oilstones, and whetstones, 1903–1907.*

| | | | |
|---|---|---|---|
| 1903 | $65,763 | 1906 | $83,863 |
| 1904 | 61,609 | 1907 | 89,939 |
| 1905 | 65,753 | | |

## CORUNDUM AND EMERY.

With the exception of the diamond, emery and corundum are the best natural abrasives known. Corundum is pure aluminum oxide with a hardness of 9 in Moh's scale, namely, next to that of the diamond. So far as composition goes, emery may be considered a mixture of corundum with more or less magnetite or hematite. The material feels and looks much like a black, fine-grained iron ore, which it was long considered to be. There is almost every gradation from the evenly fine-grained emery to the kind in which corundum is present in distinct crystals, as is frequently the case with the Peekskill emery ore.

*Peekskill emery ore.*—The deposits of emery near Peekskill, Westchester County, N. Y., are located about 4 miles southeast of the town and a few miles east of the Hudson River. It is reported that the deposits were first exploited for iron ore. The emery occurs in a series of igneous rocks intruded into metamorphic sedimentary rocks. To these intrusions the name Cortlandt series has been applied. This series includes rocks belonging mainly to the norite, diorite, and peridotite classes. The emery deposits, according to G. H. Williams,[a] are simply segregations of the basic oxides in the norite, the components of the latter rock occurring in even the purest emery ore. A study of the thin section of the material from these deposits has revealed the presence of hercynite (iron spinel), magnetite, garnet, and corundum, some of the latter being pale blue and perfectly transparent. Of these minerals, H. C. Magnus[b] states that hercynite forms, in some cases, nearly 100 per cent of the material, and in others corundum makes up more than 50 per cent of it. Hercynite is inferior in hardness to corundum, being 8 in the scale of hardness, while corundum is 9. This softness, however, is in part compensated by a readier cleavage, which causes hercynite to present fresh, sharp cutting edges.

The deposits of emery vary considerably in size. They are all worked by open cuts which vary in width and depth with the size of the ore body. The ore is blasted out by light charges of explosives, and is broken up and roughly cobbed before shipment to the mill. The subsequent mill treatment consists in cleansing and grading the rough cobbed material for use in the form of emery powder, emery paper and cloth, and emery wheels. It has been claimed that the Westchester material is very serviceable when made into wheels with a vitreous bond, but in general the selection of a bond depends upon the work to be accomplished, and the work to be accomplished should always be stated when ordering the wheel.

In 1907 the output of emery in the United States came from but two localities, Chester, Mass., and near Peekskill, N. Y. At Chester but one firm has been active, the Ashland Emery and Corundum Company; in New York four firms have either mined or shipped emery. The only change noted in the industry at Peekskill has been the taking over by the Keystone Emery Mills, of Frankford, Pa., of the properties of the late H. M. Quinn.

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[a] Am. Jour. Sci., 3d ser., vol. 33, 1887, pp. 33 *et seq.*
[b] Twenty-third Rept. State Geologist, N. Y. State Mus., 1903, pp. 163–172.

## PRODUCTION.

There was no production of corundum reported to the United States Geological Survey for the year 1907. The production of emery in the United States in 1907 amounted to 1,069 short tons, valued at $12,294. As compared with the production of 1906, the quantity of material is slightly less, and the value shows a great decrease. The valuation for 1907 is based on the rough material as it comes from the quarries at the point of shipment. All the emery mined at Peekskill is shipped to other points for grinding and for manufacture into finished forms, after which, of course, its value is greatly increased. The following table gives the total quantity and value of the corundum and emery produced in the United States since 1881, the figures for the year 1907, however, representing the value of emery alone:

*Annual production of corundum and emery, 1881–1907, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1881 | 500 | $80,000 | 1895 | 2,102 | $106,256 |
| 1882 | 500 | 80,000 | 1896 | 2,120 | 113,246 |
| 1883 | 550 | 100,000 | 1897 | 2,165 | 106,574 |
| 1884 | 600 | 108,000 | 1898 | 4,064 | 275,064 |
| 1885 | 600 | 108,000 | 1899 | 4,900 | 150,600 |
| 1886 | 645 | 116,190 | 1900 | 4,305 | 102,715 |
| 1887 | 600 | 108,000 | 1901 | 4,305 | 146,040 |
| 1888 | 589 | 91,620 | 1902 | 4,251 | 104,605 |
| 1889 | 2,245 | 105.567 | 1903 | 2,542 | 64,102 |
| 1890 | 1,970 | 89,395 | 1904 | 1,916 | 56,985 |
| 1891 | 2,247 | 90,230 | 1905 | 2,126 | 61,464 |
| 1892 | 1,771 | 181,300 | 1906 | 1,160 | 44,310 |
| 1893 | 1,713 | 142,325 | 1907 | 1,069 | 12,294 |
| 1894 | 1,495 | 95,936 | | | |

## IMPORTS.

Imported emery comes from Asia Minor, Turkey, and the island of Naxos, Greece. According to Mr. E. L. Harris, U. S. consul at Smyrna, Asia Minor, Turkey,[a] all the mines in Asia Minor which are now worked are located from 50 to 200 miles southeast of the city of Smyrna. At the mining operations near the city all of the visible emery has been removed, and the cost of extraction is almost doubled from the fact that the workings are so far below the surface. Mining operations are conducted in the most primitive fashion. In the case of the deposits remote from Smyrna, the ore is brought by camels and less frequently by mules and donkeys. The value of emery varies from $17 to $19 per ton at the point of shipment. The yearly shipments average 20,000 tons from Turkey and 7,000 tons from Naxos. Sixty per cent of this goes to the United States. The table following gives the quantity and value of emery and corundum imported into the United States from all foreign sources in the last five years.

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[a] Mining World, December 28, 1907.

*Emery and corundum imported into the United States, 1903–1907.*

| Year. | Grains. | | Ore and rock. | | Other manufactures. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Value. | |
| | *Pounds.* | | *Long tons.* | | | |
| 1903 | 3,595,239 | $109,272 | 10,884 | [a]$194,468 | $17,829 | $321,569 |
| 1904 | 2,281,193 | 109,772 | 7,054 | [b]138,931 | 11,721 | 260,424 |
| 1905 | 3,209,915 | 143,729 | 11,073 | 185,689 | 18,007 | 347,425 |
| 1906 | 4,655,668 | 215,357 | 13,841 | 286,386 | 19,339 | 521,082 |
| 1907 | 4,282,228 | 186,156 | 11,235 | 211,192 | 15,282 | 412,630 |

[a] Including emery rock valued at $5,488.  [b] Including emery rock valued at $7,338.

## CANADIAN CORUNDUM.

Canadian corundum is mined chiefly by two companies, the Ontario Corundum Company and the Canadian Corundum Company (Limited). The deposits of corundum occur in pinkish syenite and nepheline syenite, and are located in the province of Ontario. The Canadian Corundum Company (Limited) during a part of 1907 treated only corundum from its Craig mine at Craigmont, Ragland Township, Renfrew County, Ontario, where mining operations were begun in 1900.[a] In the following table are given the quantity and value of Canadian corundum during the last five years:

*Production of Canadian corundum, 1903–1907.*

| | | | |
|---|---|---|---|
| 1903 | short tons.. | 916 | $92,940 |
| 1904 | do.... | 919 | 101,050 |
| 1905 | do.... | 1,644 | 149,153 |
| 1906 | short tons.. | 2,274 | $204,973 |
| 1907 | do.... | 1,892 | 177,922 |

## ABRASIVE QUARTZ AND FELDSPAR.

### PRODUCTION.

The production of crystalline quartz and feldspar used for abrasive purposes in the United States in 1907 amounted to 17,435 short tons, valued at $126,582, as compared with a production of 24,082 short tons, valued at $121,671, in 1906. This increase in value, coupled with the decrease in production, is notable, but is explained by the greater values per ton reported by producers, due largely to the fact that the material is put on the market chiefly in the ground or partially prepared form. The quartz reported comes from Connecticut, Maryland, Massachusetts, Pennsylvania, and Wisconsin.

A large part of the output given above, namely, 47 per cent, is feldspar, which is being used in an increasingly large quantity as an abrasive. The feldspar quarried for abrasive purposes comes from Minnesota and Connecticut, and is used in the manufacture of scouring soaps, for which purpose it is especially well adapted.

In the table following is given the production of abrasive quartz from 1895 to 1903, and that of abrasive quartz and feldspar since that period.

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[a] Haultain, E. T., Canadian Mining Journal, August 1, 1907, pp. 291-296.

*Production of crystalline quartz, 1895–1907.*

| | | | |
|---|---|---|---|
| 1895 | short tons | 9,000 | $27,000 |
| 1896 | do | 6,000 | 18,000 |
| 1897 | do | 7,500 | 22,500 |
| 1898 | do | 8,312 | 23,990 |
| 1899 | do | 13,600 | 39,000 |
| 1900 | do | 14,461 | 40,705 |
| 1901 | do | 14,050 | 41,500 |
| 1902 | short tons | 15,104 | $84,335 |
| 1903 | do | 8,938 | 76,908 |
| 1904 | do | [a]31,940 | [a]74,850 |
| 1905 | do | [a]19,039 | [a]88,118 |
| 1906 | do | [a]24,082 | [a]121,671 |
| 1907 | do | [a]17,435 | [a]126,582 |

From the figures of the total production of quartz and feldspar, given on another page of this volume, it will be observed that only a small part of the production of these commodities is used solely for abrasive purposes. For a discussion of these substances and their uses the reader is referred to the report on quartz and feldspar.

## ABRASIVE GARNET.

### PRODUCTION.

The production of garnet reported for abrasive purposes in 1907 was 7,058 short tons, valued at $211,686. This is the highest production ever recorded by the Survey, exceeding that of 1906 by 2,408 tons, or 52 per cent, in quantity, and by $54,686, or 35 per cent, in value. The average price per ton of the garnet was $30.34, which is about the mean of the minimum and maximum quotations (depending on quality) on ordinary wholesale lots in New York during the year. The garnet mined came from New York, Pennsylvania, and North Carolina.

The following table gives the quantity and value of abrasive garnet produced in the United States for the years 1895 to 1907:

*Production of abrasive garnet, 1895–1907.*

| | | | |
|---|---|---|---|
| 1895 | short tons | 3,325 | $95,050 |
| 1896 | do | 2,686 | 68,877 |
| 1897 | do | 2,554 | 80,853 |
| 1898 | do | 2,967 | 86,850 |
| 1899 | do | 2,765 | 98,325 |
| 1900 | do | 3,185 | 123,475 |
| 1901 | do | 4,444 | 158,100 |
| 1902 | short tons | 3,926 | $132,820 |
| 1903 | do | 3,950 | 132,500 |
| 1904 | do | 3,854 | 117,581 |
| 1905 | do | 5,050 | 148,095 |
| 1906 | do | 4,650 | 157,000 |
| 1907 | do | 7,058 | 211,686 |

### NOTES ON THE GARNET INDUSTRY.

*New York.*[b]—The production of garnet for abrasive purposes is a well-established industry in the Adirondack region of New York. The seat of the industry is in Warren and Essex counties near the upper Hudson Valley, and North Creek, the terminus of the Adirondack branch of the Delaware and Hudson Railroad, is the principal point of shipment.

The garnet produced is almandite, the iron aluminum variety, with the symbol $3FeO.Al_2O_3.3SiO_2$. Ordinarily garnet has a hardness of 6.5 to 7.5, but it is claimed that the Adirondack garnet is harder than this, occurring from 7.5 to 8 in the scale, thus lying intermediate between quartz (7) and corundum (9). According to

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[a] Includes feldspar used for abrasive purposes.

[b] The notes on the garnet industry in New York have been largely compiled from the reports of D. H. Newland, contained in bulletins of the New York State Museum devoted to the mining and quarry industry.

Newland,[a] the garnet is usually associated with amphibolite, which occurs in lens-shaped bodies in a country rock of acid gneiss. The amphibolite has been metamorphosed, as is usual with garnet-bearing rocks. The mineral occurs in crystals ranging from an inch upward in diameter, and the larger crystals have been so strained and shattered by compression that they readily crumble into small fragments.

In working the deposits the country rock is broken down by the ordinary quarry methods of picking or blasting. The rock is then crushed sufficiently fine to release the garnets, and the product is washed. The garnet is recovered either by hand sorting or by mechanical means. Some difficulty has in the past been encountered in separating the garnet from the accompanying hornblende, but the North River Garnet Company has solved the difficulty by employing crushers and then concentrating on a special type of jigs.

The output is used in the shoe and wood-working industries, and sold in the form of garnet paper. The mineral does not possess any distinct mineral cleavage, but there is a rather distinct parting parallel to the dodecahedral faces which is usually well developed in the Adirondack mineral. This insures a smooth surface for attachment to the cloth or paper and at the same time leaves a sharp cutting edge. The resultant efficiency is said to be much greater than that of ordinary sandpaper.

The output of the region, as already mentioned, comes from Essex and Warren counties. The North River Garnet Company has a mine at Thirteenth Lake, Warren County, so situated that it is practicable to work it throughout the year; but at other points, as at Gore Mountain and Garnet Peak, where the garnet is obtained by open-cut work and hand sorting, winter work is not practicable.

In 1905 exploratory work was done on a type of deposits somewhat different from those described. The locality is on the east slope of Mount Bigelow 5½ miles south of Keeseville, near Lake Champlain. Newland has described the country rock as follows:[b]

> The country rock is anorthosite, a part of the great mass of that rock which is exposed in the central Adirondacks. It is made up of granular feldspar with a little pyroxene, biotite, and garnet, and has a more or less laminated appearance. In the vicinity of the garnet deposit the rock shows considerable variation due to included bands of amphibolite and pegmatite. The garnet does not form crystals, but occurs in irregular lens-shaped bodies of massive character that are apparently in direct contact with the anorthosite. Except for admixture with small greenish crystals of pyroxene, the garnet is quite pure. At one locality there is an almost continuous series of outcrops extending north and south for a distance of 400 feet. The greatest thickness shown is about 40 feet. The garnet usually has a finely granular texture and readily crumbles under slight pressure, but occasionally it is platy and breaks with a smooth surface. Its origin is probably to be explained by alteration similar to that which has given rise to the amphibolite bands which have been caught up during the intrusion of the anorthosite or have been folded into the latter and metamorphosed. Impure limestone would afford the necessary constituents for its formation.

During 1906 the property was under development, and the first reports of production from this area were received from Messrs. E. Schaaf-Regelman and George W. Smith, and are contained in the figures for 1907. The garnet from this locality is known to the trade as "massive garnet," and the product is of exceptional purity.

*North Carolina-Pennsylvania.*—The production of garnet from North Carolina in 1907, reported to the Survey, came from Marshall,

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[a] The mining and quarry industry of New York State: N. Y. State Mus. Bull. 102, 1906, p. 71.
[b] The mining and quarry industry of New York State: N. Y. State Mus. Bull. 102, 1906, p. 72.

Madison County. The deposits were operated by the Highland Development Company of Boston. There was no production in 1906, but the industry was on a substantial basis in 1907.

The production from Pennsylvania was reported from Chelsea, a small town situated in the extreme southeastern part of the State in Delaware County and near the State line between Pennsylvania and Delaware. The garnet is the ruby or rose-colored variety and is found in gneiss.

## INFUSORIAL EARTH AND TRIPOLI.

### PRODUCTION.

In previous reports on the production of abrasives in the United States it has been the custom to combine the statistics of infusorial earth and tripoli. So far as our present information goes, the two substances are quite different in origin and to a certain extent in their uses.

Some of the Missouri tripoli is and always has been used for abrasive purposes, but much of it is used in the manufacture of filter stones. The Illinois product [a] is employed in the paint industry, as a wood filler, for enameling purposes, etc. No attempt has heretofore been made to procure from producers of tripoli a definite statement of the exact proportion used for abrasive purposes, nor has any attempt been made to get at the tonnage of rough tripoli blocks worked up into filter stones. Even if this tonnage had been found it would be impossible to value the resultant product on a uniform basis and thus to obtain a reliable ratio between quantity and value, for the reason that the price of filter stones varies and is dependent not only on the size of the stones but also on the amount of work done on each. For this reason it has been decided in this report to give simply the value of the production of infusorial earth and tripoli and to omit the tonnage.

In the following table are given the quantity and value of infusorial earth and tripoli produced in the United States from 1880 to 1906 and the value of these products in 1907:

*Production of infusorial earth and tripoli, 1880–1907.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1880 | short tons | 1,833 | $45,660 | 1894 | short tons | 2,584 | $11,718 |
| 1881 | do | 1,000 | 10,000 | 1895 | do | 4,954 | 20,514 |
| 1882 | do | 1,000 | 8,000 | 1896 | do | 3,846 | 26,792 |
| 1883 | do | 1,000 | 5,000 | 1897 | do | 3,833 | 22,835 |
| 1884 | do | 1,000 | 5,000 | 1898 | do | 2,733 | 16,691 |
| 1885 | do | 1,000 | 5,000 | 1899 | do | 4,334 | 37,032 |
| 1886 | do | 1,200 | 6,000 | 1900 | do | 3,615 | 24,207 |
| 1887 | do | 3,000 | 15,000 | 1901 | do | 4,020 | 52,950 |
| 1888 | do | 1,500 | 7,500 | 1902 | do | 5,665 | 53,244 |
| 1889 | do | 3,466 | 23,372 | 1903 | do | 9,219 | 76,273 |
| 1890 | do | 2,532 | 50,240 | 1904 | do | 6,274 | 44,164 |
| 1891 | do | | 21,988 | 1905 | do | 10,977 | 64,037 |
| 1892 | do | | 43,655 | 1906 | do | 8,099 | 72,108 |
| 1893 | do | | 22,582 | 1907 | do | | 104,406 |

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[a] The Illinois product is called tripoli, for the reason that its origin is regarded as essentially the same as that usually assigned to the Missouri product.

## NOTES ON DEPOSITS OF INFUSORIAL EARTH.

Infusorial earth in 1907 was mined for market in the following States: California, Connecticut, Kentucky, Maryland, Massachusetts, Nevada, and New York. California led in production, that of the other States combined being a relatively small part of the whole.

Diatomaceous or infusorial earth resembles chalk or clay in its physical properties, but can be distinguished at once from the former substance by the fact that it does not effervesce when treated with acids. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter. Owing to its porosity it has great absorptive powers. Chemically, it is a variety of opal.

Heretofore the principal uses of infusorial earth have been largely for abrasive purposes, in the form of polishing powders, scouring soaps, etc., but of late its uses have been considerably extended. Owing to its porous nature it has been used in the manufacture of dynamite, as a holder of nitroglycerine. This same porous structure renders it a nonconductor of heat, which property, in connection with its lightness in weight, has extended its use as a packing material in safes, steam pipes, and boilers, and as a fireproof building material in general. The California product, according to Arnold and Anderson,[a] may be cut into any shape desired, and, like the Missouri tripoli, may be used as a filter stone. The material is quarried for building stone in southern California, for which purpose it seems to be well adapted, especially in that region of earth tremors, owing to its elasticity and because the minimum amount of damage is likely to result from the falling of so light a material.

*California.*—In California important deposits of infusorial earth are found in Los Angeles, Monterey, Orange, San Luis Obispo, Shasta, and Santa Barbara counties, and deposits are reported from San Benito, San Bernardino, and Tehama counties. The material occurring at Lompoc, in northern Santa Barbara County, is considered by Aubury[b] the best yet found in the State. The greater part of the diatomaceous earth in this region occurs in the Monterey (middle Miocene) and in the lower part of the Fernando (upper Miocene) formations, and deposits are described by Arnold and Anderson[c] in the hill south of Santa Ynez River, in the Burton mesa, in the hills between Santa Ynez and Los Alamos valleys, in the vicinity of Santa Ynez and Casmalia, in the Santa Maria oil district, in the Cañada del Gata and Sisquoc areas, in the mountains northeast of the Santa Maria Valley, and in the San Luis quadrangle.

*Maryland.*—Infusorial earth is found at the base of the Calvert formation, and comprises beds which in Anne Arundel, Calvert, and Charles counties attain a thickness of 30 to 40 feet. The only deposits worked on a commercial scale during 1907 are located near Dunkirk, Calvert County.

*New York.*—Infusorial earth occurs at several places in New York, but of late years the only deposits worked are those located near Hinckley, Herkimer County. According to Newland,[d] a bed from 2 to 30 feet thick forms the bottom of White Lead Lake.

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[a] Bull. U. S. Geol. Survey No. 315, 1907, p. 446.
[b] Bull. Cal. State Min. Bur. No. 38, 1906, p. 293.
[c] Bull. U. S. Geol. Survey No. 315, 1907, pp. 440-445.
[d] The mining and quarry industry of New York State: N. Y. State Mus. Bull. No. 102, 1906, p. 68

The deposit is under 4 feet of water. The material is excavated and purified by washing and settling in vats, after which it is compressed into cakes, and is used mainly as a polishing powder. It runs 86.5 per cent silica.

## NOTES ON THE TRIPOLI INDUSTRY.

The tripoli mined in the United States during 1907 came from Missouri and Illinois. The material produced in Union County, Ill., is called silica by the Illinois State Geological Survey,[a] but the suggestion has been made that it has essentially the same origin as the well-known tripoli deposits of Newton County, Mo. In this report, therefore, it has been regarded as tripoli, and its production is combined with that of the tripoli of Missouri.

*Missouri.*[b]—The tripoli deposits worked at the present time in Missouri are located near Seneca and Racine, Newton County. They occur in the Boone formation in bodies from 4 to 12 feet in thickness. The material is a light, even-textured rock, fairly tenacious after drying, but more or less friable when mined. It is extremely porous and light; hence the term "cotton rock," which is sometimes applied to it. No trace of fossils of any kind has been found in the deposits. The material runs over 98 per cent in silica. It is thought to have been derived from a fine, granular, and nonfossiliferous limestone from which the calcareous material has been leached, leaving the silica in a thoroughly porous condition. The tripoli is usually massive, with scarcely a trace of stratification, but is divided by various systems of joints into blocks of varying sizes. Chert in lenses or balls is commonly associated. After removing a thin mantle of clay, gravel, and residual chert from the tripoli, the material is quarried by the methods described below:

> Vertical channels 12 inches wide are cut to the bottom of the deposit, or to such depth as is desired. These channels are easily made with a light pick of ordinary shape. Where the rock is much cut up by fissures and clay seams the channels are cut along the most prominent of these joints, to lose as little as possible of the dimension stone. A 2-inch hole is then drilled between the ends of the channels, filled with unslacked lime, and tamped. By absorption of quarry sap the lime is slacked, swells, and lifts the stone, the steadily increasing pressure having a tendency to loosen up the blocks along the already existing joints, rather than to make new fractures. The shape and size of the blocks thus obtained depend on the number and attitude of the joints. The larger blocks of good quality are sent directly to the filter shop. Spalls and pieces not suitable for filters are sent to the dry sheds, to be later ground into tripoli flour. When rock for grinding only is desired, that is to say, when it is too much jointed or for some other reason is unsuitable for filter stones, powder is used instead of lime in raising the rock, as it gives blocks of smaller size and saves some hand breaking before crushing.
>
> Where the rock is not so closely beset with joints and fractures, narrow 2-inch cross channels are cut the length of the handle with a narrow-eyed pick, the eye being no wider than the cutting edge of the pick. In this way pieces of regular dimensions are obtained. Blocks 2 by 2 by 5 feet are as large as are ordinarily desired.

The rough blocks from the quarry are taken directly to the mill and are there ultimately turned into filter stones of various sizes and shapes. These are made on regular turning lathes. Defective blocks, trimmings, and the dust go to the tripoli flour mill. After thorough drying the material is crushed, ground, and bolted. Two grades are marketed, depending on the degree of fineness; the grade known as O. G. (once ground) will pass through a 60-mesh sieve, and that known as D. G. (double ground) will pass through a 140-mesh sieve. Three colors of the tripoli flour are made—white, cream, and rose. The material is sacked or barreled and shipped like ordinary flour. This fine material is used almost entirely as an abrasive.

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[a] Bain, H. F., Bull. Ill. State Geol. Survey, No. 4. 1907, p. 185.

[b] The notes on the tripoli deposits of Missouri have been compiled from the report of C. E. Siebenthal and R. D. Mesler: The tripoli deposits near Seneca, Missouri, Bull U S. Geol. Survey No. 340, 1907.

### IMPORTS.

There is an importation of infusorial earth and tripoli into the United States each year which is not separately recorded by the Department of Commerce and Labor, but which is included with rotten stone used for similar purposes. The value of the imports of rotten stone and tripoli for the past five years has been as follows: 1903, $34,977; 1904, $23,022; 1905, $18,986; 1906, $25,990; 1907, $27,121. No record is kept of the number of tons of this material imported.

### CANADIAN PRODUCTION.

The Canadian production during 1907 was 30 short tons of tripoli, valued at $225.

## PUMICE.

### PRODUCTION.

The pumice produced in the United States in 1907 amounted to 8,112 short tons, valued at $33,818. This was a decrease of 4,088 tons from the production of 1906, but there was a large increase in value, due in part to increased cost of handling the material at the mines and of getting it into cars. The production of pumice in the United States during the last five years is given in the following table:

*Production of pumice in the United States, 1903–1907, in short tons.*

| Year. | Quantity. | Value. | Price per ton. |
|---|---|---|---|
| 1903 | 885 | $2,665 | $3.01 |
| 1904 | 1,530 | 5,421 | 3.54 |
| 1905 | 1,832 | 5,540 | 3.02 |
| 1906 | 12,200 | 16,750 | 1.37 |
| 1907 | 8,112 | 33,818 | 4.17 |

### IMPORTS.

The value of imports of pumice into the United States in 1907 amounted to $85,647. This is $26,048 less than the value of the imports into the country in 1906. The figures for the last five years are given in the following table:

*Value of pumice imported into the United States, 1903–1907.*

| | | | |
|---|---|---|---|
| 1903 | $83,920 | 1906 | $111,695 |
| 1904 | 77,211 | 1907 | 85,647 |
| 1905 | 77,489 | | |

## NOTES ON DEPOSITS OF PUMICE.

The pumice produced in the United States comes from Harlan and Lincoln counties in Nebraska. Deposits are also known in South Dakota and Wyoming to the north and northwest, and in Kansas and Oklahoma on the south. Scattered deposits are also known in other of the Western States.

The term "pumice" is applied to a form of acid volcanic rock which may be either massive or in a finely comminuted state. The former variety of pumice is largely imported from the Lipari Islands, a group of volcanic islands north of Sicily in the Mediterranean Sea. It owes its peculiar porous, vesicular, or pumiceous condition to the rapid expansion of included moisture or gases due to sudden release of pressure at the time of its ejection from the volcano. This expansion may be carried to such an extent that the rock is completely shattered and the resultant finely powdered material may be carried to unknown distances by wind and air currents and then deposited in beds often several feet in thickness. The latter explanation is that usually assigned to the material composing the deposits in Harlan and Lincoln counties, Nebr.

*Nebraska.*—The Nebraska deposits have been described by Barbour.[a] According to the report of this writer practically the entire State is overlain by deposits of natural pumice, which extend as far east as Omaha. The extent and thickness of the beds are evidence of extraordinary former volcanic activity. To the north of the State in the heart of the Big Bad Lands of South Dakota beds were noted 10 to 15 feet thick. In Scotts Bluff and Banner counties, in the western part of the State, beds 100 feet thick were measured which, though not consisting wholly of volcanic ash, still were rendered white by it. The material in individual beds differs greatly in purity, texture, and physical condition. Some of the material is pure and white; in some places it is adulterated with silt, sand, clay, and particles of limestone, etc. In texture it exhibits great variety, the coarser material being found in almost every stage of consolidation from incoherent dust to fairly compact rock. Nearly all of the material is used for abrasive purposes, either in the form of polishing powders or soaps.

*Colorado.*—Woolsey[b] has recently described material of a nature similar to pumice from near Durango, La Plata County, Colo. The substance occurs in three isolated beds lying within a radius of 4 miles of the place. One is located at the east end of the dry valley north of Animas City Mountain, on the shoulder of the southward-facing spur. Opposite the west end of the same valley, on the crest of the ridge between Dry Gulch and Junction Creek, another bed occurs. Both of these deposits have the same elevation—about 400 feet above Junction Creek at this point. The third bed lies nearly east of Durango, on the east slope of Frorida Mesa, 250 feet above Florida River. All these beds lie at nearly the same elevation and have a somewhat similar mode of occurrence. The material from the three localities is very similar in appearance, resembling a dust-like powder of white opaque flakes, glistening in the sunlight. The material is gritty and entirely unconsolidated. Under the microscope the particles of the material are decidedly angular and fairly uniform in size. The material is very similar to the volcanic ash described by Merrill[a] from Montana and Idaho. The bed north of Animas City Mountain has been prospected, as has also the bed on Florida Mesa.

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[a] Barbour, E. H., Mineral Industry, vol. 4, pp. 22-25.
[b] Bull. U. S. Geol. Survey, No. 285, 1906, pp. 476-479.

Some of the possible uses of the material are in semifused filling brick and in fireproofing and mineral wool for packing as a non-conductor of heat and sound. In its natural condition it may also be used in refrigerating plants, in the manufacture of puzzolan cements, and in some of the cheaper varieties of glassware.

## ARTIFICIAL ABRASIVES.

Under the head of artificial abrasives are included carborundum, crushed steel, and alundum. The total production of these substances, by years, since 1904 is given in the following table:

*Production of artificial abrasives in the United States, in pounds, 1904–1907.*

| Year. | Quantity | Value. |
|---|---|---|
| 1904 | 11,870,380 | $830,926 |
| 1905 | 9,820,000 | 701,400 |
| 1906 | 11,774,300 | 777,081 |
| 1907 | 14,632,000 | 1,027,246 |

The production in the year 1907 was greater than that of any year of which the Survey has record, exceeding that of 1906 by 2,857,700 pounds in quantity and by $250,165 in value.

In previous reports it has been the custom to give, in addition to the total production and value of artificial abrasives, the quantity and value of each of the several commodities listed above. As single firms are engaged in making each class of artificial abrasives, the practice obtaining heretofore will be discontinued.

### CARBORUNDUM.

Carborundum is manufactured by a single firm in the United States, the Carborundum Company of Niagara Falls, N. Y. The foreign demand for this abrasive has increased so rapidly within the last few years that the company has constructed a plant at Düsseldorf, Germany, for the manufacture of carborundum wheels and abrasive articles. The factory began operations in February, 1907.

Carborundum is manufactured by fusing in the intense heat of the electric furnace a mixture of granulated coke, very pure glass sand, and sawdust. The two materials first mentioned are the purest obtainable. The coke represents the carbonaceous residue from the distillation of petroleum; the sand used is the purest glass sand. The sawdust is added entirely for mechanical purposes, namely, to make the mixture porous and thus to avoid explosions of the carbon monoxide produced during the course of the reaction. The fundamental reaction takes place between the sand (silica) and the coke (carbon), resulting in the production of a carbide of silicon, or carborundum. The details of the furnace construction and operation have been described by F. A. J. Fitzgerald,[a] and will not be considered here.

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[a] Am. Jour. Sci., 3d ser., vol. 32, 1886, pp. 199 *et seq.*

The latest developments in the industry have been summarized recently by F. J. Tone,[b] from which article the following notes are taken.

Carborundum has been used for some time in the plate glass and granite industries. The recent extension of its use to the marble industry follows as a natural course. A complete line of machinery has been developed for the various operations involved in preparing marble for market, and in this industry the use of carborundum is rapidly dispensing with the old style machine tools and with skilled labor. Carborundum is being introduced into the wood-working and paper industries, and also into the hat trade. Other applications of the material are in nonslipping stair treads, carriage treads, nonslipping horseshoes, and also in the construction of cement pavements and sidewalks.

## ALUNDUM.

The abrasive known as alundum is manufactured by the Norton Company at Niagara Falls from the mineral bauxite. The crude bauxite is first calcined to drive off combined water. This is accomplished in a rotary calciner 60 feet long, heated by two gas producers. The machine at Niagara Falls is continuously acting and will calcine 40 tons of bauxite per day.

The ore after calcination is ready for the electric furnaces. These are conically shaped pots which stand on cars and are heated by vertical electrodes, which are gradually raised as the molten bauxite fills the furnace. In the furnace room 2,000 E. H. P. are used. It is said that the temperature attained in the furnaces ranges from 5,000 to 6,000 degrees Fahrenheit. The dimensions of the furnaces are calculated so that the fusion shall not extend to the water-cooled shell. During the fusion iron is reduced from the bauxite as a result of the reducing action of the electrodes. This iron, containing 5 to 12 per cent silicon, is sold to the steel makers. These masses, which are called pigs, each contain about three tons of abrasive material

After the completion of the fusion, the furnace is taken to a position under an electric crane which removes the solidified mass and places it on the cooling floor until it is cool enough to handle. The mass is then broken up and fed to a crusher, after which the alundum passes through a reel which removes all the fine dust, which is re-fused. The product which has gone over the reel is passed over a sorting belt, where the material not up to the standard is picked out. The resulting product in fragments about the size of a man's fist is then loaded on cars and sent to the company's plant at Worcester, Mass., where it is subjected to the various operations necessary for use in the alundum wheels.

One of the recent applications of alundum is as a refractory material. The substance melts at 2,300° C., and has a very low coefficient of expansion, if it has any at all. It is, moreover, very inert chemically, and tests made in the basic open-hearth furnaces show that it is not appreciably affected by slags in these processes. A lining of a Deville furnace does not show deterioration after repeated burns at

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[a] Electro-chem. and Metallurg. Industry, February, 1906.
[b] Mineral Industry for 1906, vol. 15, 1907, pp. 95-99.

1,800° C. It remains to be proved just how much better alundum is than other standard refractories, as its cost will necessarily be quite high. It is believed, however, that for many special purposes it will prove of great value.

## CRUSHED STEEL.

The method of manufacturing crushed steel abrasives has been described by M. M. Kann, secretary and treasurer of the Pittsburg Crushed Steel Company,[a] and by Pratt.[b]

In the manufacture of crushed steel abrasives, high-grade crucible steel is heated to nearly white heat, and is then quenched in a bath of cold water. The fragments of steel thus produced are then crushed to particles varying from fine powder up to one-sixth of an inch, more or less, in diameter. The crushed product is then classified and tempered, being then known as "diamond crushed steel," "diamond steel emery," and "steelite."

The chief use of crushed steel is in the stove, brick, glass, and metal trades—the size of the steel used depending on the character of the stone to be cut, rubbed, ground, or polished.

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[a] Proc. Am. Assoc. Adv. Sci., Pittsburg meeting, July, 1903.
[b] Mineral Resources U. S., 1903, p. 1013.

# ARSENIC.

### By Frank L. Hess.

## INTRODUCTION.

The production of arsenic in the United States during 1907 was confined to three firms and places—the Everett (Washington) smelter, the Washoe smelter at Anaconda, Mont., and the Putnam County Mining Corporation, Carmel, N. Y. The arsenic plant at Mineral, Clark County, near Tacoma, Wash., did not operate during the year.

The arsenic produced by the smelters was all in the form of white arsenic (arsenic trioxide, $As_2O_3$). That made at Everett was from ores mined in the Monte Cristo district, Washington, and from flue dust of the Pacific coast plants of the American Smelters and Securities Company. That made at the Washoe smelter was from flue dust obtained in the smelting of Butte copper ores. The production at Carmel, N. Y., was in the form of arsenical pyrites (mispickel), and was shipped to England for reduction.

The following description of the deposits at Carmel and elsewhere in New York, appeared in "The mining and quarry industry of New York State, report of operations and production during 1907," by D. H. Newland: [a]

> The ore consists of arsenopyrite and subordinate pyrite with a quartz gangue occurring in veins that cut the gneiss country rock in proximity to a basic dike now altered to serpentine. The veins are made up of a number of parallel stringers closely set and forming what is properly called a lode. There are two such lodes of which the one worked has a northerly strike and is from 12 to 20 feet wide, while the second lode intersecting at an angle of 60° has been only prospected. The ore body is opened by a vertical shaft bottomed at 100 feet, from which a drift has been run along the course of the lode. It is about 12 feet wide in the drift.
>
> During the past year the company has installed a plant for concentrating the low grade material. The process as described by Edward K. Judd [b] consists in passing the ore through a jaw crusher and rolls and treating by hydraulic jigs of the Joplin type. There are eight jigs run by hand and provided with ¼-inch screens. The arsenopyrite is recovered from the hutch only, the material on the screens being rejected. The jig capacity is 4½ tons of crude ore or 1½ tons of concentrates each per day. The concentrates average 25 per cent arsenic.

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[a] Bull. New York State Museum No. 112, 1907, p. 13.

[b] Eng. and Min. Jour., New York, vol. 85, 1908, p. 306.

A sample of the high grade ore gave the following percentages on analysis:

*Analysis of arsenic ore from Carmel, N. Y.*

| | |
|---|---|
| Silica | 2.90 |
| Iron | 36.11 |
| Copper | 2.17 |
| Sulphur | 22.72 |
| Arsenic | 36.00 |
| | 99.90 |

Arsenopyrite occurs near Edenville and at other localities in Orange County, and in the town of Lewis, Essex County, 10 miles south of Keeseville. The Edenville deposit carries also leucopyrite, the diarsenid of iron and scorodite, a hydrous arsenate of iron.

In Maine an arsenical pyrites deposit on Verona Island, below Bangor, was prospected, but no output was made.

At Darrington, in Washington, the Summit Mining Company, of Wellsville, N. Y., has claims on White Horse Mountain, upon which only assessment work was done during the year.

## PRODUCTION AND IMPORTS.

The output of arsenic in the United States during 1907, calculated as arsenic trioxide, and including the content of the ores shipped from Carmel, N. Y., was 1751 short tons, valued at about $163,000.

Although arsenic ore was exported from this country, the importation of arsenic and arsenical salts was the largest ever known, as was the domestic production.

Enormous quantities of arsenic in fumes continually escape from the smelters of the country, while at present comparatively little arsenic is saved. Harkins and Swain in "Papers on smelter smoke"[a] state that in August, 1905, from the Washoe smelter, which works exclusively upon Butte copper ores, 59,270 pounds of arsenic trioxide per day were passing through the stack. This is equivalent to 21,633,550 pounds, or 10,817 short tons per year, and is exclusive of what arsenic trioxide was saved from the flues. At 5 cents per pound, the lowest price for which white arsenic sold during 1907, this waste product of one year would be valued at $1,081,700. The waste arsenical fumes at this plant alone amount to more than six times the domestic saving of arsenic trioxide, and to much more than the combined production and imports of arsenic in the United States each year.

At the Butte Reduction Works and the Great Falls smelter other great quantities of more or less arsenical Butte copper ores are treated, from which no saving of arsenic is known to have been made and from which the losses must be very great.

In Utah both the Bingham and the Tintic copper ores are arsenical, and no saving has yet been made from them, though immense quantities of ore are smelted.

It is recognized that in handling a low-priced product like arsenic, saving can not be carried to extreme refinement without becoming unprofitable. However, arsenic is now being extracted from sulphuric acid at a number of establishments in England, and both products are cheap articles. If even one-half of the arsenic wasted were saved, the market in this country would be glutted. However, without taking account of the possibility of greater demand if there were a greater supply at a somewhat lower price, there will in time probably be some plan devised for the better saving of smelter fumes, through the operation of which it will be unnecessary for this country to import arsenic while so much is continually being wasted.

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[a] Jour. Amer. Chem. Soc., vol. 19, 1907, pp. 970–998.

The production and importation of arsenic, white arsenic, and arsenic sulphides since 1901, and of London purple and Paris green since 1904, is given in the table below. The production of each year is composed only of white arsenic or the white arsenic content of the ore produced.

*Production and imports of arsenic, 1901–1907.*

| Year. | Production. | | Imports. | | | |
|---|---|---|---|---|---|---|
| | White arsenic. | | White arsenic, metallic arsenic, and arsenic sulphides. | | Paris green and London purple. | |
| | Quantity (short tons). | Value. | Quantity (short tons). | Value. | Quantity (pounds). | Value. |
| 1901 | 300 | $18,000 | 3,495 | $316,525 | .......... | .......... |
| 1902 | 1,353 | 81,180 | 4,055 | 280,055 | .......... | .......... |
| 1903 | 611 | 36,691 | 4,179 | 294,602 | .......... | .......... |
| 1904 | 36 | 2,185 | 3,400 | 243,380 | 28,498 | $985 |
| 1905 | 754 | 85,210 | 3,838 | 256,540 | 44,931 | 1,118 |
| 1906 | 737 | 63,460 | 3,987 | 350,045 | 311,293 | 21,347 |
| 1907 | 1,751 | 163,000 | 5,164 | 574,998 | 133,422 | 21,919 |

Besides these importations, sheep dip, a large part of which is arsenical, was imported to the value of $19,696. One of these dips consists of sodium arsenide, arsenic sulphide, and sulphur. Under customs regulations no record is kept of importations of arsenic compounds known by the trade names of Scheele's green, lead arsenate, lead arsenite (pink arsenoid), barium arsenoid (white arsenoid), green arsenoid, aniline arsenate, or other arsenic salts than those given above.

### PRODUCTION IN FOREIGN COUNTRIES.

The principal producing countries are Germany, Spain, Portugal, France, England, Turkey, and Canada. The figures obtainable are largely in terms of ore carrying an unknown percentage of arsenic, and are thus too indefinite to be serviceable. The output of white arsenic from Germany, Spain, and England, probably exceeds considerably in each case that from the United States.

### PRICES.

Prices varied in 1907 from 5 to 8 cents per pound in large lots at the smelters. The prices for large lots in New York City, as given by the Oil, Paint, and Drug Reporter, opened in January at from 7¾ to 8 cents per pound, and reached a maximum during late February and early March. During the larger part of this latter period prices ranged from 8 to 8½ cents; during the remainder of the year there was a steady but very gradual decline, and the year closed with 5⅞ to 6 cents as the prevailing price. Red arsenic sold at from 6¾ to 8 cents per pound, and was higher during the last part of the year than during the first part. In December arsenate of soda was quoted at 6¾ cents per pound.

# BORAX.

By Charles G. Yale.

## INTRODUCTION.

Very marked changes occurred in the borax industry in the United States in 1907, resulting in the virtual closing down of most of the former producers in California, the only State in the Union producing this substance in commercial quantities. While the total yield in 1907 was only 5,323 tons less than in 1906, and the decrease in value only $60,890, yet the sudden drop in market value was such that by the end of 1907 only the largest properties continued to carry on mining operations. In fact, most of the producers say it does not pay to mine borax properties under present circumstances and will not start up again until there are more promising conditions, and some of the companies which were working on low-grade properties do not expect to resume operations and have removed their plants from the mines. The consumption of borax has not materially increased, and in some branches of industry it has actually decreased. At the same time new mines opened within the year are prepared to meet even extraordinary demands as to output. New uses for borax are constantly being looked for by the producers in order that they may enlarge the market.

## PRODUCTION.

California continues to be the only State which makes a commercial production of borax annually, the few small marsh deposits in Nevada being no longer productive. In 1907 the entire output was derived from the counties of San Bernardino, Inyo, and Ventura, Cal. The output of crude borax for 1907 was 52,850 short tons, valued at $1,121,520, as compared with 58,173 short tons, valued at $1,182,410 in 1906. Until 1903 the annual statistics were based on quantity and value of the refined or manufactured product, but since then the crude material has been taken as the basis of quantity, and the percentage of boric acid contained taken as the basis of value. The colemanite, or borate of lime mined, varies in richness of boric acid at different properties, and these percentages being ascertained, the values are fixed accordingly. This is explained in detail in the chapter on this subject in the report for 1905.

The statistics of production of borax in California from 1895 to 1907, inclusive, are given in the following table, the values for the years 1903 to 1907, inclusive, being based on the boric-acid content of the corresponding number of crude tons of colemanite or borate of lime:

*Production of borax in California, 1895–1907.*

| | | |
|---|---|---|
| 1895..short tons.. | 5,959 | $595,900 |
| 1896......do...... | 6,754 | 675,400 |
| 1897......do...... | 8,000 | 1,108,000 |
| 1898......do...... | 8,000 | 1,120,000 |
| 1899......do...... | 20,357 | 1,139,882 |
| 1900......do...... | 25,837 | 1,013,251 |
| 1901......do...... | 23,231 | 1,012,118 |
| 1902..short tons. | [a] 20,004 | $2,538,614 |
| 1903......do..... | [b] 34,430 | 661,400 |
| 1904......do..... | [b] 45,647 | 698,810 |
| 1905......do..... | [b] 46,334 | 1,019,154 |
| 1906......do..... | [b] 58,173 | 1,182,410 |
| 1907......do..... | [b] 52,850 | 1,121,520 |

## IMPORTS.

The following table shows the imports of borax and borates into the United States from 1902 to 1907, inclusive:

*Imports of borax and borates into the United States, 1902–1907, in pounds.*

| Year. | Borax. | | Borates, calcium, and sodium (crude) and refined sodium borate. | | Boric acid. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 684,537 | $20,795 | 186,807 | $12,002 | 822,907 | $30,439 |
| 1903 | 68,978 | 5,727 | 146,654 | 13,280 | 693,619 | 28,011 |
| 1904 | 153,952 | 10,569 | 89,447 | 6,630 | 708,815 | 27,658 |
| 1905 | 166,960 | 8,802 | 20,395 | 1,626 | 676,105 | 22,872 |
| 1906 | 791,425 | 27,343 | 57,711 | 2,436 | 986,021 | 33,200 |
| 1907 | 2,268,065 | 77,258 | 2,959 | 175 | 534,524 | 23,547 |

## REVIEW OF THE BORAX INDUSTRY IN 1907.

### CALIFORNIA.

The main feature of the borax industry since about the middle of 1907 has been the steady reduction in price, which fell from 6½ to 7 cents per pound at New York early in the year to 4½ and 5½ cents per pound during the latter part of the year. This fall in price is considered as having been inaugurated by the Pacific Coast Borax Company, the leading producer, partly because of the lower cost of production which would follow the completion of the Tonopah and Tidewater Railroad to the Lila C. mine of that company in Inyo County, Cal., which was opened for production in May, 1908; partly in view of competitive conditions regarding both production and markets, and partly with a view to stimulate consumption.

It was this reduction in price which caused the closing of most of the other productive mines in California. Some of them had virtually exhausted the ore of a profitable grade in their properties; others were suffering from the expenses of transportation and were making but small profit, which was entirely wiped out when the price fell.

The cost of the crude substance mined differs quite materially with the different producers, owing to local conditions, longer or shorter haul to railroads, methods of mining, etc. Some of it is concentrated or semirefined before shipment, being subsequently fully refined at places distant from the source of production. Some producers bring their product to a higher percentage of boric acid than others before shipping to the refineries at New York, Chicago, San Francisco, New Jersey, or Pennsylvania.

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[a] Refined product, including 2,600 short tons of crude, valued at $91,000. [b] Crude product.

The company which is the leading producer of borax in its commercial forms states that in that portion of the United States served from its Chicago headquarters, comprising 23 States and a population of 40,000,000, with 427 cities and towns each exceeding 5,000 in population, about one-half of the prepared borax sold is used for household purposes. Of this company's entire output in the United States, about one-third finds household use. Among the industrial uses of this company's borax in the territory named that by meat packers has undergone a striking change through the operation of the pure-food laws. Before the passage of those laws, 40 per cent of the company's sales in this territory were to meat packers; in 1907 the proportion was only about 3 per cent. In the industrial uses that year in the territory referred to, that by metal-ware enamelers amounted to 49 per cent of the sales; large chemical dealers took 23 per cent, meat packers 3 per cent, manufacturers of plumbing supplies 3 per cent, tanners 2 per cent, and various trades and dealers the remainder.

The leading producers of boracic acid and prepared borax have recently been making strong efforts to stimulate the consumption of borax along all possible lines. The forms of the product designed for household use are becoming more varied, and are more widely and persistently advertised. The use of borax in tanning has been considerably increased.

One of the California companies has offered a prize of $500 for a commercially successful electric process for the making of ferroboron, which compound has been found to increase so greatly the tensile strength of steel when used as an alloy to the extent of one-half of 1 per cent to 1 per cent that the company foresees a possible large increase in consumption of boron compounds.

In 1907 there were 5 producing mines in California, 1 in Inyo, 2 in San Bernardino, and 2 in Ventura counties. With one exception these properties had ceased production by the end of that year, though some of the operators have since commenced operations at other and more favorable places.

*Inyo County.*—In Inyo County is situated the Lila C. mine of the Pacific Coast Borax Company, which began to be productive in the latter part of 1907, and has since been yielding by far the largest part of the entire output of the State. The mine lies 12 miles west of the main line of the Tonopah and Tidewater Railroad, owned by the principal owners of the mine, and is connected by a short line with the main railroad. The colemanite vein in the mine is from 6 to 18 feet wide, and carries a boric acid content of about 40 per cent. The property has been under development for several years and is fully opened. It was the intention of the company to abandon, when the new railroad was completed, its old mines at Daggett, San Bernardino County, and draw its entire supply of ore from this Lila C. mine, Inyo County, where the ore is rich and plentiful. For this reason development was commenced some years before it was practicable to utilize the output. Indeed, for a number of years the company has had prospectors out looking for borates, and it now owns virtually all the mounds and foothills of Furnace Creek "wash" in the Death Valley region of Inyo County. The mine is in the hills on the western edge of the Amargosa Desert. In the Amargosa Canyon are old abandoned borax claims still owned by this same company. The crude ore from the Lila C. mine is to be shipped direct to the refinery at Bayonne, N. J., without being concentrated or semirefined in any way. The Pacific Coast Borax Company is enabled to obtain its entire supply from this single mine.

The Western Borax Works in this same county made a small output in 1907, which was shipped to San Francisco; but the company ceased operations when prices fell in the latter part of the year.

*San Bernardino County.*—From this county both the Pacific Coast Borax Company and the American Borax Company obtained a production in 1907 from their deposits near Daggett. Neither the Western Mineral Company nor the Palm Borate Company produced. The Pacific Coast Borax Company has abandoned its mines at Daggett entirely, and its plant and machinery have been removed. The American Borax Company has given up its mine also and removed all its material. The Western Mineral Company has closed down its mine and will not resume operations until prices are bettered.

A new company known as the Borax Properties, Limited, has been organized in England, and has taken over the properties of the Palm Borate Company near Daggett, as well as other groups of borax claims in Belleville district. Capital has been supplied to put up the necessary plant for mining and for crystallizing the product. The Palm Borate Company was organized as far back as 1902, and has since been developing its mine by tunnel and shafts. Large quantities of borate of lime are exposed above the tunnel levels. After preliminary treatment of the crude ore, the solution of boric acid will be carried by pipe line to the Salt Lake Railroad station and there be crystallized in tanks.

The Los Angeles stockholders of the Palm Borate Company still retain an interest in these properties, and the management continues to be local. During 1908 contracts have been let for machinery, plant, etc., and by the end of the year the properties are expected to become productive. This will then be the only producing borax property in San Bernardino County, which has always heretofore been the county of the State making the largest output of borax.

*Ventura County.*—In this county the Frazier Borate Company, controlled by the Stauffer Chemical Company, of San Francisco, and the Columbus Borax Company, managed by M. Calm & Bros., of New York, both were producers in 1907. In April of that year the Frazier Company closed down its mine, and in October the Columbus Company did the same. The long haul to the railroad would not permit the continuance of operations with the prices for borax as they were at that time.

Notwithstanding the closing down of these long-worked properties, a new organization called the Russell Borate Mining Company has acquired some 600 acres of ground in the Frazier region, between the properties of the Frazier and the Columbus companies. The owners claim that the material to be mined is of higher grade than that mined by the old companies. They have therefore, in 1908, formed a corporation to exploit this new ground, which has not heretofore been worked.

*Los Angeles County.*—Until November, 1907, no borax deposits were known to exist in Los Angeles County, but in that month colemanite was discovered by a prospector in Tick Canyon, a branch of Soledad Canyon, 40 miles north of the city of Los Angeles, and 5 miles from Lang Station, on the Southern Pacific Railroad. This mine is the nearest of its kind in the State to a shipping station and to tidewater. Some 20 claims were located, and have since been purchased by the Sterling Borax Company, which has its headquarters in Los Angeles. The vein is of colemanite and, if the claims of the owners are valid, it is one of the best bodies of that ore yet discovered in California. Cheap transportation is an important factor in working such properties, and this the mine possesses. Comparatively cheap labor may also be obtained in that locality, whereas in the desert region not only labor but supplies are more expensive than they are near the coast and close to railroad lines and large cities. During 1908 the new mine has been developed, and some ore has been shipped to San Francisco, Chicago, and New Brighton, Pa. The company will ship crude ore to refineries at the above-named places, and will erect no refinery or concentrating works at the mine. It is understood that the Stauffer Chemical Company, of San Francisco, which formerly operated the Frazier Borate Company in Ventura County, has a controlling interest in this company, and the owners of the New Brighton, Pa., refinery are also interested, as are manufacturers of sanitary plumbing ware, agate utensils, etc., in Chicago. During the latter part of 1908 this deposit is being actively worked and is in a position to make a large output of high-grade material.

The Sterling Borax Company is virtually a combination which includes not only the deposits mentioned, but the Ventura mines of the Frazier Borate Company or Stauffer Chemical Company, the Lang and the Death Valley mines of the American Borax Company, and the refining companies at Chicago, San Francisco, and New Brighton.

The uses to which borax is put are given in detail in the chapter on this subject in the report of 1905.

# FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.

## FLUORSPAR.

### CHARACTER AND OCCURRENCE.

Fluorspar or fluorite, chemically calcium fluoride ($CaF_2$), consists of calcium and fluorine in the proportions of 51.1 to 48.9. The mineral is crystalline, only slightly harder than calcite, and consequently crushes easily. It crystallizes in the isometric system, and is found commonly in cubical crystals. In color the spar ranges, according to purity, from a clear, slightly bluish glasslike substance through various brilliant shades, although much of it is white and opaque. The mineral is usually very pure, the greater part of the material marketed running 98 to 99 per cent, while material carrying less than 95 per cent of calcium fluoride finds little sale, except at a reduced price.

Fluorspar, associated with other minerals, has a broad distribution geographically and a wide range geologically. The deposits thus far exploited in the United States are, however, confined to five States—Arizona, Colorado, Illinois, Kentucky, and Tennessee.

The Arizona production has come mainly from the Castle Dome district, Yuma County. In 1902, 1903, and 1904, small quantities of fluorspar were shipped from this locality, but during the last three years there has been no production reported beyond that required for assessment work. In Colorado the fluorspar occurs in Boulder and Custer counties, along the Front Range. The chief deposits in Illinois and Kentucky occur in adjoining portions of the two States, Hardin and Pope counties in Illinois being separated from the Kentucky counties, Crittenden, Livingston, and Caldwell, by Ohio River. The great size and the purity of the fluorspar deposits of the Illinois-Kentucky district indicate that for many years they will continue the main source of domestic production. Prospecting with favorable results has been reported from Mercer County, in central Kentucky. The Tennessee production has been from Smith and Trousdale counties, near the central part of the State. A possible addition to the list of producing States is California, since fluorspar deposits in San Bernardino County are now being investigated. Fluorspar is secured as a by-product of lead and zinc mining in Albemarle County, Va.; with gold tellurides at the Cripple Creek mines, Colorado, and at a number of other localities in quantities too small for use at present. Practically, wherever it has been mined, fluorspar occurs as a vein-material, although under widely different conditions. In the Kentucky-Illinois district it is the chief mineral of value in many of the veins, lead and zinc being of secondary importance, and, in many places, not valuable even as by-products, while in the Castle Dome district of Arizona jig concentrates of fluorspar are made incidental to concentrating the lead-silver ores.

## PREPARATION AND USES.

The various uses of fluorspar depend on its chemical composition, fluxing properties, and phosphorescence when heated, and on its optical and gem-like properties. Its preparation involves separation from other minerals with which it is associated, the treatment comprising hand-sorting, crushing, and jigging. Part of the high-grade ore is ground and shipped in barrels and sacks; the rest is sold in lump form. Where fluorspar is associated with zinc blende, complete separation of the two minerals has been difficult on account of their nearness in specific gravity. While fluorspar is useful in smelting iron ores it is harmful to zinc, and therefore the zinc-fluorspar concentrates have been of little value until recently. A new process for separating fluorspar and zinc by means of flotation in a dilute solution of aluminum sulphate is now in successful operation at Marion, Ky. This basic flotation process is performed in shallow pans, in which mechanical stirrers are operated, and an increased production of both minerals has resulted.

The three principal classes of consumers of fluorspar are, in order of importance, smelters and metallurgists, makers of opalescent glass and enameled wares, and chemical manufacturers. The highest grade, "American lump No. 1," which runs less than 1 per cent silica, and is white or clear pale blue in color, is sold either ground or in lumps for use in the glass, enameling, and chemical industries, the latter including the manufacture of hydrofluoric acid. The grinding of the pure, clear spar can be dispensed with for some purposes, as it readily decrepitates to a powder when heated. The second grade, "American lump No. 2," is used by blast furnaces in the production of ferrosilicon and ferromanganese, and in basic, open-hearth steel furnaces to give increased fluidity to the slag and to reduce the contents of phosphorus and sulphur. This grade includes colored spar and may run as high as 4 per cent silica, though most of it is sold with a 3 per cent guaranty. The lowest grade, "gravel spar," including all that contains more than 4 per cent silica as well as spar mixed with calcite, is used in iron and brass foundries, where it is of value in making the metal more fluid, in permitting the use of greater quantities of lower grades and scrap, and because it carries phosphorus, sulphur, and other impurities into the slag.

Fluorspar possesses a considerably higher quantitative efficiency as a flux than limestone, especially in smelting refractory ores; but in all metallurgical operations the proportions of the spar that can be used are limited, since its favorable effects do not increase indefinitely as the quantity is increased. In England and on the Continent the use of fluorspar is at present more common than in America, probably because its value has been better understood by European metallurgists. Other minor metallurgical uses are in the extraction of aluminum from bauxite, in smelting gold ores, in refining copper, and in refining lead bullion. In the latter process the spar is first converted into hydrofluoric acid. Miscellaneous uses that have been reported are as a bonding for constituents of emery wheels, for carbon electrodes to increase their lighting efficiency while also decreasing the amount of current required, and as a constituent of Portland cement.

## PRODUCTION AND PRICES.

The total quantity of fluorspar marketed in 1907 is reported at 49,486 short tons, valued at $287,342, which represents a gain in quantity of 8,690 short tons and in value of $43,317 over the output for 1906. This indicates a firm condition in the fluorspar industry, since there was on hand at the close of 1906 a stock of 13,470 tons,[a] which has evidently been absorbed without leaving quite so large a surplus on hand at the close of 1907. The production from Kentucky increased considerably in 1907, and more spar was ground in this State than in Illinois. The production from Illinois decreased slightly, although Illinois still reports the larger production. Colorado shows a large proportional increase in 1907, but no production was reported from either Arizona or Tennessee. Illinois reported a total production of 25,128 short tons, valued at $141,971. Of this total, 18,610 short tons were gravel spar, valued at $83,259, or $4.47 per ton; lump spar was 3,038 tons, valued at $22,828, or $7.51 per ton; and ground fluorspar was 3,480 tons, valued at $35,884, or $10.31 per ton. Small quantities of lump spar were reported to have sold at $18 to $35 per ton. Kentucky's total production of 21,058 short tons, valued at $133,971, was reported as follows: Gravel, 14,276 tons, valued at $71,376, or $4.99 per ton; and ground spar, 6,782 tons, valued at $62,595, or $9.23 per ton. All the Colorado product, 3,300 short tons, was reported as crude or gravel, and was valued at $11,400, or $3.45 per ton.

Up to October, 1907, the demand for fluorspar was generally strong, with prices ranging from 75 cents to $1 in advance of those of 1906. Toward the end of the year there was a decided falling off in production as a result of the depression in the iron and steel business that followed the financial stringency. Many producers found, however, that the net result of the year's business was no worse than that of 1906, and others report decided gains.

Wholesale prices[b] in December, 1907, on domestic lump spar free on board shipping point ranged from $8 to $10 per long ton; on ground spar, from $11.50 to $13.50 per long ton; and on foreign crude, ex dock, from $8 to $10 per long ton. In May, 1908, the quotations were exactly the same.

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[a] Fohs, F. Julius, Fluorspar: Mineral Industry for 1906, p. 323, 1907.
[b] Eng. and Min. Jour., December 7, 1907, and May 2, 1908.

The following table gives the quantities and values of the different grades of fluorspar produced and marketed in the United States in 1906 and 1907:

*Fluorspar marketed in 1906 and 1907, in short tons.*

| State. | Gravel. | | Lump. | | Ground. | | Total quantity. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| 1906. | | | | | | | | |
| Colorado | | | | | | | (a) | (a) |
| Illinois | | | [b]23,739 | [b]$113,399 | 4,529 | $47,224 | 28,268 | $160,623 |
| Kentucky | | | [c]8,207 | [c]40,084 | [c]4,321 | [c]43,318 | [d]12,528 | [d]83,492 |
| Total | | | 31,946 | 153,483 | 8,850 | 90,542 | 40,796 | 244,025 |
| 1907. | | | | | | | | |
| Colorado | 3,300 | $11,400 | | | | | 3,300 | 11,400 |
| Illinois | 18,610 | 83,259 | 3,038 | 22,828 | 3,480 | 35,884 | 25,128 | 141,971 |
| Kentucky | 14,276 | 71,376 | | | 6,782 | 62,595 | 21,058 | 133,971 |
| Total | 36,186 | 166,035 | 3,038 | 22,828 | 10,262 | 98,479 | 49,486 | 287,342 |

[a] Included in Kentucky.
[b] Includes crude and gravel spar.
[c] Includes crude and gravel spar from Colorado and Tennessee.
[d] Includes production from Colorado and Tennessee.

The annual production of fluorspar in the United States since 1883 is given in the following table:

*Production of fluorspar in the United States, 1883–1907.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1883 | short tons | 4,000 | $20,000 | 1896 | short tons | 6,500 | $52,000 |
| 1884 | do | 4,000 | 20,000 | 1897 | do | 5,062 | 37,159 |
| 1885 | do | 5,000 | 22,500 | 1898 | do | 7,675 | 63,050 |
| 1886 | do | 5,000 | 22,000 | 1899 | do | 15,900 | 96,650 |
| 1887 | do | 5,000 | 20,000 | 1900 | do | 18,450 | 94,500 |
| 1888 | do | 6,000 | 30,000 | 1901 | do | 19,586 | 113,803 |
| 1889 | do | 9,500 | 45,835 | 1902 | do | 48,018 | 271,832 |
| 1890 | do | 8,250 | 55,328 | 1903 | do | 42,523 | 213,617 |
| 1891 | do | 10,044 | 78,330 | 1904 | do | 36,452 | 234,755 |
| 1892 | do | 12,250 | 89,000 | 1905 | do | 57,385 | 362,488 |
| 1893 | do | 12,400 | 84,000 | 1906 | do | 40,796 | 244,025 |
| 1894 | do | 7,500 | 47,500 | 1907 | do | 49,486 | 287,342 |
| 1895 | do | 4,000 | 24,000 | | | | |

## PRODUCTION OF FLUORSPAR IN ENGLAND.

The fluorspar produced in England is obtained mainly from mines, but a small quantity is obtained from open quarries. The output is from the counties of Derby and Durham. Derby produces the variety of fluorspar known as "Blue John," used in making ornaments. The total quantity of fluorspar produced from these two counties in 1906 was 41,849 long tons, valued at the mines at $97,442, as compared with 39,446 long tons, valued at $95,174. From 1899, when the fluorspar obtained was only 783 tons, the production increased very rapidly up to 1905. The average value per ton in 1906 was $2.33, which is $1.12 less than the lowest valuation placed on American spar at the mines. The fluorspar imported into the United States is said to come largely from English mines, the competition being felt principally along the Atlantic coast. No statistics regarding the importation of this mineral are yet available from the Department of Commerce and Labor.

## CRYOLITE.

### IMPORTS AND PRICES.

No cryolite was reported to have been produced in the United States in 1907. Cryolite is aluminum-sodium fluoride, and is used chiefly in the manufacture of sodium salts, of opal and alabaster glass, of porcelain and enameled ware, and as a flux in the electrolytic aluminum process. The mineral is quarried in Greenland, and there were imported into the United States in 1907, 1,438 long tons, valued at $28,902, as compared with 1,505 long tons, valued at $29,583, in 1906.

Wholesale prices on cryolite at the close of 1907 and the first part of 1908 were 6½ to 6¾ cents per pound.

## RECENT LITERATURE ON FLUORSPAR AND CRYOLITE.

For details as to geologic relations, mining developments, and notes on the technology of the preparation and uses of fluorspar the reader is referred to the following papers:

Bain, H. F. Fluorspar deposits of the Kentucky-Illinois district: Mines and Minerals, November, 1904, pp. 182–183.

———. The fluorspar deposits of southern Illinois: Bull. U. S. Geol. Survey No. 255, 1905.[a] 15c.

———. Principal American fluorspar deposits: Min. Mag., August, 1905, pp. 115–119.

Betts, Anson G. The manufacture of hydrofluoric acid: Mineral Industry, 1906, pp. 330–332.

Blake, W. P. Historical sketch of mining in Arizona: Report of the governor of Arizona to the Secretary of the Interior, 1899, pp. 106–107.

Burchard, E. F. Production of fluorspar and cryolite in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1063–1067.[a]

Canby, H. S. The cryolite of Greenland: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 6 [continued], 1898, pp. 615–617.

Egglestone, William Morley. The occurrence and commercial uses of fluorspar: Trans. Inst. Min. Eng., vol. 35, pt. 2, London, England, May, 1908, pp. 236–268.

Emmons, S. F. Fluorspar deposits of southern Illinois: Trans. Am. Inst. Min. Eng., vol. 21, 1893, pp. 31–53.

Fohs, F. Julius. Fluorspar: Eng. and Min. Jour., January 6, 1906, pp. 45–46.

———. Fluorspar deposits of Kentucky, with notes on production, mining, and technology of the mineral in Bull. Kentucky Geol. Survey No. 9, 1907.

Miller, Arthur M. The lead and zinc bearing rocks of central Kentucky: Bull. Kentucky Geol. Survey No. 2, 1905.

Phenis, Albert. Kentucky fluorspar, lead, and zinc: Mfrs. Record, November 22, 1906, p. 467.

Ulrich, E. O., and Smith, W. S. T. The lead, zinc, and fluorspar deposits of western Kentucky: Prof. Paper U. S. Geol. Survey No. 36, 1905.

Watson, Thomas L. Lead and zinc deposits of Virginia: Bull. Virginia Geol. Survey No. 1, 1905, p. 42.

Wheeler, G. D. Zinc in Crittenden County, Ky.: Eng. and Min. Jour., vol. 74, 1902, pp. 413–414.

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[a] Out of stock, but usually accessible in libraries of cities, technical schools, and universities, and for sale by the superintendent of documents, Government Printing Office, Washington, D. C.

# GYPSUM.

By Ernest F. Burchard.

## RANGE AND DISTRIBUTION OF GYPSUM.

Gypsum occurs in sedimentary rocks of practically all ages, either in the crystalline form or as rock gypsum, and it is widely distributed geographically. It is found in places in the vicinity of beds of rock salt. In the United States workable deposits are confined to beds of rock gypsum, which occur at comparatively few geological horizons. The beds of rock gypsum east of Missouri River are, for the most part, in Paleozoic rocks, while those of the West are mostly of Mesozoic and Tertiary age. The white gypsum sands of Arizona and New Mexico consist of fine-grained material that has been eroded from rock outcrops and worked in Quarternary time by the winds into its present condition and position.

Gypsite deposits consist of masses of gypsum grains mixed with more or less clayey matter and sand. Some of these deposits lie in basin-like depressions, but others have been found on rounded hilltops at the horizon of beds of rock gypsum and evidently residual from them. The theory generally advanced for the formation of gypsite deposits is that the material has been deposited by the evaporation of spring waters containing in solution gypsum which has been derived from underlying beds of the mineral. The writer is inclined to the belief, however, that certain recently observed gypsite deposits in Oklahoma are probably the result of erosion and concentration by water of disintegrated rock gypsum. About 5 miles northeast of Watonga, Blaine County, Okla., deposits of gypsite occur as a silt in a shallow valley cut between gypsum-crested hills. The gypsite lies at a lower level than the two beds of gypsum which occur in the hills, and from the character and relations of the materials the gypsum ledges have apparently contributed the disintegrated material which has been washed down and spread out in the valley below.

Rock gypsum is produced in sixteen of the United States and in one Territory, besides Alaska. In most of the producing localities the material is mined from underground workings, but in Oklahoma it is still quarried, since outcropping ledges still afford available rock. Gypsite deposits, owing to their nature, are worked in the open, and where this material is of good quality it is regarded as particularly valuable on account of the low cost of excavation.

## GYPSUM PRODUCTS.

The bulk of the gypsum produced in the United States as well as in foreign countries is manufactured by grinding and partial or complete calcination into the various plasters, such as plaster of Paris, stucco, cement plaster, flooring plaster, hard-finish plaster, etc. A steadily increasing quantity is being used as a retarder in Portland cement. Refined grades of plaster are used in dental work, also as cement for plate glass during grinding, and as an ingredient in various patent cements. Considerable quantities are ground without burning and used as land plaster or fertilizer, while smaller quantities are used in the manufacture of paint and paper, imitation meerschaum and ivory, and as an adulterant. The pure white massive form, known as alabaster, is much used by sculptors for interior ornamentation.

For plaster of Paris and for dental, molding, and casting plasters a high grade of rock gypsum, ground very fine, is required, and the product is not mixed with any foreign substance or retarder, but is used in the pure or "neat" condition. Such plasters are quick setting and usually white in color. Much of the so-called cement plaster is made directly from gypsite, an impure unconsolidated earthy or sandy form of gypsum, which in many places is found to contain a suitable percentage of foreign material, so that the addition of a retarder is not necessary to effect a slow set. Where gypsite deposits are not available, cement plasters are made from rock gypsum by the addition of various mineral or organic retarders. A large part of the structural plaster now produced is used in specially prepared conditions that appeal to the builder on account of their convenience. A plaster board is pressed from plaster interlaminated with sheets of thin cardboard. This plaster board is furnished in thin sheets, 32 by 36 inches, comprising 8 square feet of surface, and is designed to be nailed directly to the studding in place of lath, and to receive a coat of wall plaster directly on its outer surface. Fibered plaster is molded into both solid and hollow blocks and tiles, which are used in partitions and interior construction, and these, as well as the plaster board, have been proved to be of value as fire retarders.

Wall plasters are of two general grades—one a brown or gray coat—and the other a white or tinted finish coat. The wall plasters are commonly made with wood fiber or hair filler, and a wood-pulp plaster is also being made that is finding use on the outside as well as on the inside of houses. Gypsum is used in the manufacture of calcimines, in water paints and tints, and to a considerable extent as an ingredient in dry colors, notably in Venetian reds. When used in excess in mineral paints it is regarded as an adulterant. The unburned, or the dead-burned, forms of gypsum may be used to a certain extent with oil paints, because they are chemically inactive. The partially dehydrated form is not suitable for such use, but can be used with water.

## CONDITION OF THE GYPSUM INDUSTRY IN 1907.

Notwithstanding the curtailment of building operations during the season of 1907, the trade in gypsum products during the year was fairly satisfactory until late in the autumn. Pacific coast and Alaskan producers, with few exceptions, report increased demands. The gypsum reserves of California are extensive, many deposits being as yet worked only to the extent required for assessment, owing to remoteness from railroads. Some gypsum is being accumulated incidental to development of oil lands. California plaster manufacturers are fortunate in being able to use oil as a fuel in their mills. The California product is practically all disposed of within the State. Colorado firms report but little change from 1906 conditions. One new mill began production in October. In Iowa one new mill finished its first year of business. There is considerable competition in Iowa, owing to the concentration of the gypsum industry, but the principal producers are holding their own. In Kansas there was an increased production, principally from old producers. Reports from Michigan indicate that the demand for gypsum products was not quite so good as in 1906.

There was no production whatever reported from Montana during 1907. There are two small mills in the State, both of which have in former years produced plaster from a very pure grade of rock gypsum mined in Carbon and Cascade counties. The commercially productive gypsum deposits of Montana lie on the eastern base or foothills of the main Rocky Mountain range.[a] There are several beds of gypsum, ranging from a few feet to as much as 50 feet in thickness. Some of these beds, where undeveloped, can be reached by railroad spurs less than 5 miles in length. In Nevada there was a large increase in the plaster business. One new mill was built which was just beginning operations early in 1908, and development work in southern Nevada has disclosed a deposit of gypsum on which a mill is expected to be erected in 1908. In New Mexico two mills were in operation during the year. In New York State two new mills began operations in 1907, and two more mills are reported building early in 1908. The trade in New York and Ohio was, on the whole, better than in 1906, although conditions were generally quiet in the late months of the year.

The trade in Oklahoma was about normal. The autumn business depression was felt there as elsewhere. In this State the materials are obtained from open quarries and fields rather than from mines. The supply for wall plaster is drawn largely from gypsite deposits, which are not of wide extent and are comparatively soon exhausted. New gypsite deposits are, however, being discovered, and as mills have to be abandoned in one place new ones are built in others. It is also the custom to ship the raw material from some deposits perhaps a third of the distance across the State for treatment. Some ledges of rock gypsum are being quarried, but gypsite, so long as it lasts, will probably be regarded as preferable for wall plasters by practical plaster men in Oklahoma. The main reasons for this are that gypsite costs less to quarry, since it can be taken up rapidly by means of scrapers instead of requiring blasting and breaking, and that the material is often found to contain nearly, if not exactly, the right proportions of silica and other impurities to make a good wall plaster when calcined, and therefore does not require the admixture of retarders.

Gypsite that is unusually impure or that contains considerable surface soil may be brought up to the requisite standard by the addition of rock gypsum in the batch.

Gypsite deposits are eagerly being sought for, especially adjacent to railway routes, and if their origin shall in many instances prove to be sedimentary, as suggested on page 3, instead of being occasioned by spring deposits, as has heretofore been generally accepted, then deposits of this sort may be looked for under a covering of soil in many of the shallow, dry hollows among the gypsum buttes in Oklahoma and Texas. Prof. C. N. Gould [a] has ventured the opinion that not 10 per cent of available gypsite deposits in Oklahoma have yet come to light. In the same paper he has approximated the quantity of available rock gypsum in Oklahoma, and obtains the enormous total of 125,800,000,000 tons, much of which is underground. It is evident to all who are familiar with the field that there are vast reserves of rock gypsum in the Kansas-Oklahoma-Texas gypsum area. Cheap mining in the Oklahoma field is offset in part by the high cost of fuel and the transportation of the finished product to market. If it is found practicable to pipe natural gas from eastern Oklahoma to the gypsum mills and to furnish it at a rate that will enable it to be utilized, manufacturing conditions might be still further improved.

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[a] Rowe, J. P., Montana gypsum deposits: Mines and Minerals, September, 1907, pp. 59-60.

South Dakota producers report slightly better conditions during the greater part of 1907. In Texas conditions were not greatly changed, there being a slight increase in sales for the year. Local demands for material in Utah ran far ahead of those in 1906, but the production was not largely increased. In Virginia, although one new plant began production, the trade as a whole did not show a thoroughly satisfactory condition. Wyoming producers found trade either about the same or slightly better.

## PRODUCTION AND DISPOSITION.

The gypsum mined in the United States in 1907 amounted to 1,751,748 short tons. The greater part of this output was converted during the year into the various products already mentioned, and the total value of these gypsum products, plus the value of the gypsum sold crude, was $4,942,264. The production for 1906 far exceeded that of any previous year, but in 1907 the gypsum mined increased in quantity 211,163 tons, or 13.7 per cent, and the total value increased $1,104,289, or about 28.8 per cent, as compared with the corresponding figures for 1906. These statistics indicate an excellent rate of growth in the industry notwithstanding the handicaps of a season of financial depression. The quantities of gypsum mined and of manufactured gypsum do not agree in any year, since the weights of calcined gypsum are given after burning, and also because there is always some crude gypsum mined which is not manufactured in the same year, while some imported material is ground and calcined in this country.

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[a] Gould, C. N., Extent and importance of Oklahoma gypsum deposits: Min. Sci., December 19, 1906, p. 584.

The following tables show the quantity of crude gypsum mined in the United States, the marketed output by States and uses, and the disposition of the marketed product:

*Crude gypsum mined in the United States, 1880–1907.*

| | Short tons. | | Short tons. |
|---|---|---|---|
| 1880 | 90,000 | 1894 | 239,312 |
| 1881 | 85,000 | 1895 | 265,503 |
| 1882 | 100,000 | 1896 | 224,254 |
| 1883 | 90,000 | 1897 | 288,982 |
| 1884 | 90,000 | 1898 | 291,638 |
| 1885 | 90,405 | 1899 | 486,235 |
| 1886 | 95,250 | 1900 | 594,462 |
| 1887 | 95,000 | 1901 | 633,791 |
| 1888 | 110,000 | 1902 | 816,478 |
| 1889 | 267,769 | 1903 | 1,041,704 |
| 1890 | 182,995 | 1904 | 940,917 |
| 1891 | 208,126 | 1905 | 1,043,202 |
| 1892 | 256,259 | 1906 | 1,540,585 |
| 1893 | 253,615 | 1907 | 1,751,748 |

*Production of gypsum in the United States in 1906 and 1907, by States and uses, in short tons.*

| State. | Total mined. | Sold crude. | | Sold crude, ground, as land plaster. | | Sold as calcined plaster. | | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| **1906.** | | | | | | | | |
| **Alaska, Colorado, Montana, New Mexico, South Dakota, and Utah** | 30,830 | [a] 30,896 | $121,729 | (b) | (b) | [a] 25,658 | $129,344 | $251,073 |
| **California, Nevada, and Oregon** | 69,571 | 3,811 | 7,622 | 2,893 | $10,360 | 42,847 | 217,988 | 235,970 |
| **Iowa** | 286,857 | 9,862 | 15,414 | 3,751 | 6,922 | 146,526 | 551,162 | 573,498 |
| **Kansas** | 105,091 | 18,048 | 19,858 | 2,046 | 3,052 | 64,351 | 224,662 | 247,572 |
| **Michigan** | 341,716 | 27,517 | 39,679 | 30,220 | 71,340 | 208,715 | 642,859 | 753,878 |
| **New York** | 288,631 | 72,658 | 161,344 | 7,858 | 14,938 | 161,218 | 573,614 | 749,896 |
| **Ohio and Virginia** | 132,805 | ........ | ........ | [c]15,903 | 50,680 | 70,916 | 250,290 | 300,970 |
| **Oklahoma and Texas** | 247,937 | 24,197 | 94,899 | ........ | ........ | 179,350 | 630,219 | 725,118 |
| **Wyoming** | 37,147 | (d) | (d) | ........ | ........ | (d) | (d) | (d) |
| **Total** | 1,540,585 | 186,999 | 460,545 | 62,671 | 157,292 | 899,581 | 3,220,138 | 3,837,975 |
| **1907.** | | | | | | | | |
| **Alaska, Colorado, Montana, New Mexico, South Dakota, and Utah** [e] | 96,389 | 13,349 | 53,961 | 1,221 | 4,884 | 72,872 | 343,961 | 402,806 |
| **California, Nevada, and Oregon** | 80,879 | 20,902 | 38,302 | 6,161 | 28,288 | 49,860 | 227,456 | 294,046 |
| **Iowa** | 251,874 | 17,272 | 24,837 | 1,562 | 4,278 | 162,965 | 701,268 | 730,383 |
| **Kansas** | 155,980 | 27,211 | 33,572 | 3,395 | 6,364 | 96,347 | 374,330 | 414,266 |
| **Michigan** | 317,261 | 36,543 | 56,681 | 15,500 | 23,981 | 197,666 | 600,689 | 681,351 |
| **New York** | 324,507 | 101,721 | 196,426 | 5,716 | 14,687 | 145,132 | 589,112 | 800,225 |
| **Ohio and Virginia** | 202,253 | 4,473 | 9,399 | 13,296 | 33,359 | 146,565 | 626,779 | 669,537 |
| **Oklahoma and Texas** | 282,461 | 11,075 | 11,049 | ........ | ........ | 223,254 | 813,568 | 824,617 |
| **Wyoming** | 40,144 | ........ | ........ | ........ | ........ | 30,640 | 125,033 | 125,033 |
| **Total** | 1,751,748 | 232,546 | 424,227 | 46,851 | 115,841 | 1,125,301 | 4,402,196 | 4,942,264 |

[a] Includes Wyoming.
[b] Included in Ohio and Virginia.
[c] Includes also the production of Utah and a small quantity of unground material from Ohio.
[d] Included with Alaska, Colorado, etc., group.
[e] Plants in Montana idle in 1907.

*Production of gypsum in the United States, 1903–1907, classified as to uses.*

| Year. | Sold crude. | | | Sold crude, ground, as land plaster. | | |
|---|---|---|---|---|---|---|
| | Quantity in short tons. | Value. | Average price per ton. | Quantity in short tons. | Value. | Average price per ton. |
| 1903 | 73,912 | $87,608 | $1.19 | 74,601 | $154,945 | $2.08 |
| 1904 | 56,137 | 61,234 | 1.09 | 70,167 | 142,490 | 2.03 |
| 1905 | 67,105 | 106,041 | 1.58 | 40,196 | 74,280 | 1.85 |
| 1906 | 186,999 | 460,545 | 2.46 | 62,671 | 157,292 | 2.50 |
| 1907 | 232,546 | 424,227 | 1.82 | 46,851 | 115,841 | 2.47 |

| Year. | Sold as calcined plaster. | | | Total value. |
|---|---|---|---|---|
| | Quantity in short tons. | Value. | Average price per ton. | |
| 1903 | 742,543 | $3,550,390 | $4.77 | $3,792,943 |
| 1904 | 665,340 | 2,580,601 | 3.88 | 2,784,325 |
| 1905 | 736,708 | 2,848,906 | 3.87 | 3,029,227 |
| 1906 | 899,581 | 3,220,138 | 3.58 | 3,837,975 |
| 1907 | 1,125,301 | 4,402,196 | 3.91 | 4,942,264 |

*Disposition of gypsum in the United States, 1906–7, by uses, in short tons.*

| | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Sold crude: | | | | |
| For Portland cement | 168,326 | $400,669 | 194,535 | $355,750 |
| For plaster material | 13,863 | 39,458 | 36,061 | 66,597 |
| As land plaster | 62,281 | 156,652 | 46,851 | 115,841 |
| For other purposes | [a] 5,200 | 21,058 | [a] 1,950 | 1,880 |
| Sold calcined: | | | | |
| For dental plaster | (b) | (b) | 11,648 | 24,394 |
| As plaster of Paris, wall plaster, etc | 880,538 | 3,142,098 | 1,060,107 | 4,211,821 |
| To glass factories | (b) | (b) | 5,785 | 17,164 |
| For Portland cement and other purposes | 19,043 | 78,040 | 47,761 | 148,817 |
| Total | 1,149,251 | 3,837,975 | 1,404,698 | 4,942,264 |

[a] Including paint material. [b] Included in "For Portland cement and other purposes."

## IMPORTS.

The following table shows the imports for consumption of gypsum into the United States from 1903 to 1907, inclusive:

*Gypsum imported and entered for consumption in the United States, 1903–1907, in short tons.*

| Year. | Ground or calcined. | | Unground. | | Value of manufactured plaster of Paris. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| 1903 | 3,526 | $22,784 | 265,958 | $301,379 | $54,434 | $378,597 |
| 1904 | 3,278 | 11,276 | 294,238 | 321,306 | 23,819 | 356,401 |
| 1905 | 3,889 | 20,883 | 399,230 | 402,328 | 22,948 | 446,152 |
| 1906 | 3,587 | 22,821 | 436,909 | 464,725 | 21,183 | 508,729 |
| 1907 | 1,979 | 12,825 | 453,911 | 486,205 | 36,628 | 535,658 |

## WORLD'S PRODUCTION.

The following table gives the world's production of gypsum from 1902 to 1906, inclusive:

*World's production of gypsum, 1902–1906, in short tons.*

| Year. | France. |  | United States. |  | Canada. |  |
|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 1,975,513 | $3,318,070 | 816,478 | $2,089,341 | 332,045 | $359,277 |
| 1903 | 1,798,508 | 3,134,891 | 1,041,704 | 3,792,943 | 314,489 | 388,459 |
| 1904 | 1,749,875 | 2,916,483 | 940,917 | 2,784,325 | 340,761 | 372,924 |
| 1905 | 1,414,596 | 2,343,943 | 1,043,202 | 3,029,227 | 435,789 | 581,543 |
| 1906 | 1,517,603 | 2,423,615 | 1,540,585 | 3,837,975 | 417,755 | 591,828 |

| Year. | Great Britain. |  | German Empire. |  | Algeria. |  | Cyprus. |  |
|---|---|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity | Value. |
| 1902 | 251,629 | $384,263 | 34,944 | $12,732 | [a] 6,889 | $52,253 | 7,874 | $17,443 |
| 1903 | 246,282 | 337,391 | 34,054 | 19,145 | 31,967 | 105,040 | 11,591 | 28,796 |
| 1904 | 262,086 | 354,138 | 25,095 | 17,307 | 33,951 | 93,287 | 12,449 | 31,721 |
| 1905 | 286,169 | 400,717 | .......... | .......... | 38,297 | 98,420 | .......... | .......... |
| 1906 | 252,030 | 362,761 | .......... | .......... | 30,809 | 85,446 | .......... | .......... |

[a] Includes Tunis.

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# PHOSPHATE ROCK.

By F. B. Van Horn.

## INTRODUCTION.

Phosphate mining began in the United States in 1868 in South Carolina, with a production of 12,262 tons of crude rock. The existence of the rock had been known since 1837, but the possibilities of its commercial use were not recognized until 1859. According to Otto A. Moses:[a]

> In 1859 Professor Shepard and Col. L. M. Hatch suggested the utilization of phosphatic marls in the manufacture of commercial fertilizers, and started a factory at or near Charleston, which was, however, soon abandoned. Remains of their compost heap were utilized by neighboring farmers with good effect long after the war.
>
> At the close of the war Dr. N. A. Pratt, formerly connected with the niter bureau of the Confederacy, visited Charleston, with the object of starting sulphuric acid chambers. About this time Dr. St. Julien Ravenel, of Charleston, who had mined marl extensively at Stoneys Landing, on Cooper River, for the manufacture of cements, noticed the nodules, analyzed some of them, and found them to contain much phosphate of lime. He became engaged soon after in the manufacture of commercial fertilizers from foreign phosphate rocks. Then followed the discovery (in August, 1867) which has been of such vital importance to agriculture and the prosperity of South Carolina. Pratt and Holmes (Charleston Mining Company), Ravenel and Dukes (Wando Company), then located territory. The value of the deposits became known; other available beds were discovered, and many persons and considerable capital were soon employed in developing the new industry by mining the crude rock and exporting or manufacturing it on the spot into superphosphates. Later on, the beds of many navigable streams were found to be largely paved with the valuable substance.

Until 1888 South Carolina enjoyed a monopoly of the phosphate industry of the United States. In that year Florida came forward as a phosphate State, with a production of 3,000 long tons. In 1904 the production surpassed that of South Carolina, and Florida has maintained its lead up to the present time.

In 1892 phosphate was discovered in Tennessee, and two years later the production from that State was 19,188 long tons. In 1899 Tennessee went ahead of South Carolina, the production from the latter State having decreased steadily since 1894.

North Carolina, Alabama, and Pennsylvania have produced phosphate rock, but never on a large scale. In 1900 Arkansas entered the field as a phosphate producer, but thus far the output has not been large. Recently large bodies of phosphate rock have been discovered in Idaho, Wyoming, and Utah. F. B. Weeks[b] of this Survey has published a short article concerning these beds in which he says:

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[a] Mineral Resources U. S. for 1882, U. S. Geol. Survey, 1883, p. 512.

[b] Advance chapter from Bulletin No. 340, Contributions to Economic Geology, 1907, pt. 1; U. S. Geol. Survey, 1908.

> This field embraces the largest area of known phosphate beds in the world, and at some future time it will doubtless furnish a large part of the world's production of commercial fertilizer. The development of intensive farming as the result of the reclamation of arid lands in the West will afford an increasing home market.

## PRODUCTION.

The year 1907 showed a considerable advance in production of phosphate rock over 1906, as well as a substantial gain in value of the product. In Florida the dry weather favored the hard rock mining; in South Carolina labor conditions were better than in 1906, and in Tennessee a large number of new companies contributed to the increase in production, although the shortage of cars, and, toward the latter part of the year, the financial disturbance, prevented what probably would have been an exceedingly large increase. Throughout the country the demand for the rock was much greater than in previous years and this heavy demand was a large factor in causing the higher prices.

The following table shows the production of phosphate rock in the United States in 1906 and 1907:

*Production of phosphate rock in the United States, 1906-7, based on the quantity marketed.*

| State. | 1906. |  | Average price per ton. | 1907. |  | Average price per ton. |
|---|---|---|---|---|---|---|
|  | Quantity (long tons). | Value. |  | Quantity (long tons.) | Value. |  |
| **Florida:** |  |  |  |  |  |  |
| Hard rock | 587,598 | $3,440,276 | $5.85 | 646,156 | $4,065,375 | $6.29 |
| Land pebble | 675,444 | 2,029,202 | 3.00 | 675,024 | 2,376,261 | 3.52 |
| River pebble | 41,463 | 116,100 | 2.80 | 36,185 | 136,121 | 3.76 |
| Total | 1,304,505 | 5,585,578 | 4.28 | 1,357,365 | 6,577,757 | 4.85 |
| **South Carolina:** |  |  |  |  |  |  |
| Land rock | 190,180 | 711,447 | 3.74 | 228,354 | 883,965 | 3.87 |
| River rock | 33,495 | 105,621 | 3.15 | 28,867 | 96,902 | 3.36 |
| Total | 223,675 | 817,068 | 3.65 | 257,221 | 980,867 | 3.81 |
| **Tennessee:** |  |  |  |  |  |  |
| Brown rock | 510,705 | 2,027,917 | 3.97 | 594,594 | 2,880,904 | 4.85 |
| Blue rock | 35,669 | 114,997 | 3.22 | 38,993 | 142,382 | 3.65 |
| White rock | 1,303 | 5,077 | 3.90 | 5,025 | 24,550 | 4.89 |
| Total | 547,677 | 2,147,991 | 3.92 | 638,612 | 3,047,836 | 4.77 |
| **Other States** | [a] 5,100 | 28,800 | 5.65 | [b] 12,145 | 47,068 | 3.88 |
| Grand total | 2,080,957 | 8,579,437 | 4.12 | 2,265,343 | 10,653,558 | 4.70 |

[a] Includes Arkansas and Idaho.

[b] Includes Arkansas, Idaho, Utah, and Wyoming.

From this table it will be seen that the increase in production for 1907 over 1906 was 184,386 long tons, and the increase in value of product was $2,074,121. The average price per ton was 58 cents more in 1907 than in 1906—an increase of 14 per cent.

The figures shown in the foregoing table are based on the marketed production. The actual quantity of phosphate rock mined in Florida for the year 1907 was 1,386,578 long tons; in South Carolina it was 262,198 long tons, and in Tennessee 707,710 long tons—a total of 2,356,486 tons.

The quantity and value of phosphate rock marketed in the United States since 1880 have been as follows:

*Marketed production (long tons) of phosphate rock in the United States, 1880–1907.*

| Year. | Quantity. | Value. |
|---|---|---|
| 1880 | 211,377 | $1,123,823 |
| 1881 | 266,734 | 1,980,259 |
| 1882 | 332,077 | 1,992,462 |
| 1883 | 378,380 | 2,270,280 |
| 1884 | 431,779 | 2,374,784 |
| 1885 | 437,856 | 2,846,064 |
| 1886 | 430,549 | 1,872,936 |
| 1887 | 480,558 | 1,836,818 |
| 1888 | 448,567 | 2,018,552 |
| 1889 | 550,245 | 2,937,776 |
| 1890 | 510,499 | 3,213,795 |
| 1891 | 587,988 | 3,651,150 |
| 1892 | 681,571 | 3,296,227 |
| 1893 | 941,368 | 4,136,070 |
| 1894 | 996,949 | $3,479,547 |
| 1895 | 1,038,551 | 3,606,094 |
| 1896 | 930,779 | 2,803,372 |
| 1897 | 1,039,345 | 2,673,202 |
| 1898 | 1,308,885 | 3,453,460 |
| 1899 | 1,515,702 | 5,084,076 |
| 1900 | 1,491,216 | 5,359,248 |
| 1901 | 1,483,723 | 5,316,403 |
| 1902 | 1,490,314 | 4,693,444 |
| 1903 | 1,581,576 | 5,319,294 |
| 1904 | 1,874,428 | 6,580,875 |
| 1905 | 1,947,190 | 6,763,403 |
| 1906 | 2,080,957 | 8,579,437 |
| 1907 | 2,265,343 | 10,653,558 |

## PRODUCTION BY STATES.

### FLORIDA.

The production from Florida was greater in 1907 than in any previous year in its phosphate history. The output for 1907 was 1,357,365 tons, valued at $6,577,757. As compared with 1906, when the production was 1,304,505 tons, valued at $5,585,578, this represents an increase of 52,860 tons, or over 4 per cent. The output of hard rock increased 58,558 tons; that of the land pebble decreased 420 tons; and that of the river pebble decreased 5,278 tons. The total values of all three kinds showed a substantial increase. The price of hard rock was $6.29 in 1907, as against $5.85 in 1906; of land pebble $3.49, as against $3; and of river pebble $3.76, as against $2.80. The average price of Florida phosphate for 1907 was $4.85, as compared with $4.28 in 1906—a gain of 13.3 per cent. In 1907 Florida furnished 59.9 per cent of the entire production of the United States.

The following table shows the total tonnage and value of phosphate rock marketed in Florida since the beginning of the industry in 1888:

*Output of phosphate rock in Florida, based on marketed product, 1888–1907, in long tons.*

| Year. | Quantity. | Value. |
|---|---|---|
| 1888 | 3,000 | $21,000 |
| 1889 | 4,100 | 28,000 |
| 1890 | 46,501 | 338,190 |
| 1891 | 112,482 | 703,013 |
| 1892 | 287,343 | 1,418,418 |
| 1893 | 438,804 | 1,979,056 |
| 1894 | 527,653 | 1,666,813 |
| 1895 | 568,061 | 2,112,902 |
| 1896 | 495,199 | 1,547,353 |
| 1897 | 552,342 | 1,493,515 |
| 1898 | 600,894 | 1,847,796 |
| 1899 | 726,420 | $2,804,061 |
| 1900 | 706,243 | 2,983,312 |
| 1901 | 751,996 | 3,159,473 |
| 1902 | 785,430 | 2,564,197 |
| 1903 | 860,336 | 2,986,824 |
| 1904 | 1,072,951 | 3,974,304 |
| 1905 | 1,194,106 | 4,251,845 |
| 1906 | 1,304,505 | 5,585,578 |
| 1907 | 1,357,365 | 6,577,757 |
| Total | 12,395,731 | 48,043,407 |

The quantity and value of each grade or variety of phosphate rock produced in Florida from 1903 to 1907, inclusive, based upon reports of marketed material, is shown in the following table:

*Phosphate rock marketed in Florida, 1902–1907, classified by grades, in long tons.*

| Year. | Hard rock. | | Land pebble. | | River pebble. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 412,876 | $1,988,243 | 390,882 | $885,425 | 56,578 | $113,156 | 860,336 | $2,986,824 |
| 1904 | 531,087 | 2,672,184 | 460,834 | 1,102,993 | 81,030 | 199,127 | 1,072,951 | 3,974,304 |
| 1905 | 577,672 | 2,993,732 | 528,587 | 1,045,113 | 87,847 | 213,000 | 1,194,106 | 4,251,845 |
| 1906 | 587,598 | 3,440,276 | 675,444 | 2,029,202 | 41,463 | 116,100 | 1,304,505 | 5,585,578 |
| 1907 | 646,156 | 4,065,375 | 675,024 | 2,376,261 | 36,185 | 136,121 | 1,357,365 | 6,577,757 |

Nearly all of the Florida hard rock is exported. The shipments of Florida hard-rock phosphates from 1902 to 1907, inclusive, as reported by Messrs. Auchincloss Brothers, have been as follows:

*Shipments of Florida hard-rock phosphate, 1902–1907, in long tons.*

| | | | |
|---|---|---|---|
| 1902 | 492,610 | 1905 | 585,491 |
| 1903 | 467,872 | 1906 | 565,953 |
| 1904 | 494,044 | 1907 | 597,963 |

These shipments have gone to Germany, Holland, England, Belgium, Norway and Sweden, and Austria.

### SOUTH CAROLINA.

There was a considerable increase in the production of South Carolina phosphate rock during the year. Since 1893 the production has been steadily decreasing, except in 1898 and 1904, during which years there was a small increase. In 1907 the production was 257,221 tons, valued at $980,867, as compared with 223,675 tons, valued at $817,068, in 1906—an increase of 33,546 tons, or about 15 per cent. The production of land rock increased 38,174 tons, while that of river rock decreased 4,628 tons. The price of land rock was $3.87 in 1907, as compared with $3.74 in 1906; that of river rock was $3.36 in 1907, as compared with $3.15 in 1906. The average price of South Carolina rock in 1907 was $3.81, against $3.65 in 1906, a gain of 4.4 per cent. South Carolina furnished 11.4 per cent of the entire United States production in 1907.

The following table shows the total tonnage and value of phosphate rock marketed in South Carolina since 1867. Values are estimated for the years 1867 to 1880 at $5 per ton.

*Production of marketed phosphate rock in South Carolina, 1867–1907, in long tons.*

| Year ending— | Quantity. | Value. | Year ending— | Quantity. | Value. |
|---|---|---|---|---|---|
| May 31— | | | Dec. 31—Continued. | | |
| 1867 | 6 | $7,248,380 | 1888 | 448,567 | $2,018,552 |
| 1868 | 12,262 | | 1889 | 541,645 | 2,892,276 |
| 1869 | 31,958 | | 1890 | 463,998 | 2,875,605 |
| 1870 | 65,241 | | 1891 | 475,506 | 2,948,138 |
| 1871 | 74,188 | | 1892 | 394,228 | 1,877,709 |
| 1872 | 58,760 | | 1893 | 502,564 | 2,157,014 |
| 1873 | 79,203 | | 1894 | 450,108 | 1,745,576 |
| 1874 | 109,340 | | 1895 | 431,975 | 1,411,032 |
| 1875 | 122,790 | | 1896 | 402,423 | 1,181,649 |
| 1876 | 132,478 | | 1897 | 358,280 | 986,572 |
| 1877 | 163,000 | | 1898 | 399,884 | 1,107,272 |
| 1878 | 210,322 | | 1899 | 356,650 | 1,078,099 |
| 1879 | 199,365 | | 1900 | 329,173 | 1,041,970 |
| 1880 | 190,763 | | 1901 | 321,181 | 961,840 |
| 1881 | 266,734 | 1,980,259 | 1902 | 313,365 | 919,725 |
| 1882 | 332,077 | 1,992,462 | 1903 | 258,540 | 783,803 |
| 1883 | 378,380 | 2,270,280 | 1904 | 270,806 | 861,317 |
| 1884 | 431,779 | 2,374,784 | 1905 | 270,225 | 878,169 |
| 1885 | 395,403 | 2,339,468 | 1906 | 223,675 | 817,068 |
| Dec. 31— | | | 1907 | 257,221 | 980,867 |
| 1885 | 277,789 | 1,805,629 | | | |
| 1886 | 430,549 | 1,848,939 | Total | 11,912,959 | 53,221,272 |
| 1887 | 480,558 | 1,836,818 | | | |

These are corrected figures and show a total production of 11,912,959 tons, with a total value of $53,221,272.

The following table gives the quantity and value of each variety of phosphate rock marketed in South Carolina from 1903 to 1907, inclusive:

*Phosphate rock marketed in South Carolina, 1903–1907, classified by grades, in long tons.*

| Year. | Land rock. | | River rock. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 233,540 | $721,303 | 25,000 | $62,500 | 258,540 | $783,803 |
| 1904 | 258,806 | 830,117 | 12,000 | 31,200 | 270,806 | 861,317 |
| 1905 | 234,676 | 774,447 | 35,549 | 103,722 | 270,225 | 878,169 |
| 1906 | 190,180 | 711,447 | 33,495 | 105,621 | 223,675 | 817,068 |
| 1907 | 228,354 | 883,965 | 28,867 | 96,902 | 257,221 | 980,867 |

## TENNESSEE.

The year 1907 showed a larger production of phosphate rock in Tennessee than ever before. The total output was 638,612 tons, valued at $3,047,836. This is a gain of 90,935 tons in quantity and of $899,845 in value over 1906, when the production was 547,677 tons, valued at $2,147,991. This represents a gain of 16.6 per cent in production, notwithstanding a severe car shortage from August to October. The value of white rock in 1907 as compared with 1906 increased from $3.90 to $4.89; of blue rock from $3.22 to $3.65 and of brown rock from $3.97 to $4.85. The average price per ton of all phosphate rock increased from $3.92 to $4.77, a gain of 21.6 per cent. In 1907 Tennessee furnished 28.2 per cent of the entire production of the

United States. The brown rock constituted in 1907 over 93 per cent of the total Tennessee output.

The total tonnage and value of phosphate rock marketed in Tennessee since the beginning of production in 1894 are shown in the following table:

*Production of marketed phosphate rock in Tennessee, 1894–1907, in long tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1894 | 19,188 | $67,158 | 1902 | 390,799 | $1,206,647 |
| 1895 | 38,515 | 82,160 | 1903 | 460,530 | 1,543,567 |
| 1896 | 26,157 | 57,370 | 1904 | 530,571 | 1,745,054 |
| 1897 | 128,723 | 193,115 | 1905 | 482,859 | 1,633,389 |
| 1898 | 308,107 | 498,392 | 1906 | 547,677 | 2,147,991 |
| 1899 | 424,109 | 1,177,160 | 1907 | 638,612 | 3,047,836 |
| 1900 | 454,491 | 1,328,707 | | | |
| 1901 | 409,653 | 1,192,090 | Total | 4,859,991 | 15,920,636 |

The following table shows the tonnage and value of each grade of Tennessee phosphate marketed from 1905 to 1907, inclusive:

*Phosphate rock marketed in Tennessee, 1905–1907, classified by grades, in long tons.*

| Year. | Brown rock. | | Blue rock. | | White rock. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1905 | 438,139 | $1,509,748 | 44,031 | $121,486 | 689 | $2,155 | 482,859 | $1,633,389 |
| 1906 | 510,705 | 2,027,917 | 35,669 | 114,997 | 1,303 | 5,077 | 547,677 | 2,147,991 |
| 1907 | 594,594 | 2,880,904 | 38,993 | 142,382 | 5,025 | 24,550 | 638,612 | 3,047,836 |

Auchincloss Brothers give the shipments of Tennessee phosphate rock by water from Pensacola, Norfolk, and Newport News, from 1903 to 1907, as follows:

*Shipments of Tennessee phosphate rock, 1903–1907, from Pensacola, Norfolk, and Newport News, in long tons.*

| | | | |
|---|---|---|---|
| 1903 | 111,915 | 1906 | 98,846 |
| 1904 | 122,964 | 1907 | 95,589 |
| 1905 | 99,925 | | |

Practically all of these shipments have gone to foreign ports.

OTHER STATES.

No production of phosphate has been reported from North Carolina since 1903, nor from Pennsylvania since 1904. Arkansas showed a considerable increase over 1906, although the output is still small. Idaho showed a slight decrease, and Utah entered the list for the first time. The last two States will probably soon show increased activity.

## IMPORTS.

The following table shows the imports of fertilizers of all kinds into the United States for the years 1903–1907, inclusive:

*Fertilizers imported and entered for consumption in the United States, 1903–1907, in long tons.*

| Year. | Guano. | | Kieserite and kainite. | | Apatite, bone dust, crude phosphates, and other substances used only for manure. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| 1903 | 21,985 | $252,132 | 158,313 | $773,758 | 246,042 | $2,231,575 | $3,257,465 |
| 1904 | 37,127 | 498,702 | 218,957 | 1,050,082 | 243,130 | 2,455,618 | 4,004,402 |
| 1905 | 27,104 | 379,667 | 351,053 | 1,850,622 | 197,115 | 2,450,835 | 4,681,124 |
| 1906 | 23,222 | 322,766 | 334,843 | 1,790,969 | 211,274 | 2,598,451 | 4,712,186 |
| 1907 | 30,287 | 400,004 | 346,266 | 2,526,584 | 194,121 | 2,579,843 | 5,506,431 |

## WORLD'S PRODUCTION.

The world's production of phosphate rock for the years 1904 to 1906, inclusive, is given in the following table:

*World's production of phosphate rock, 1904–1906, by countries, in metric tons.*

| Country. | 1904. | | 1905. | | 1906. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Algeria | 343,317 | $1,325,104 | 334,784 | $1,225,126 | 333,531 | $965,600 |
| Aruba (Dutch West Indies) | 23,128 | (a) | 23,307 | (a) | 26,138 | (a) |
| Belgium | 202,480 | 252,263 | 193,305 | 332,292 | 152,140 | 282,612 |
| Canada | 832 | 4,590 | 1,179 | 8,425 | 680 | 5,500 |
| Christmas Island (Straits Settlements) | 72,905 | (a) | 99,519 | (a) | 92,010 | (a) |
| France | 423,521 | 1,909,859 | 476,720 | 2,093,118 | 469,408 | 1,872,000 |
| Norway | 1,456 | 19,564 | 2,522 | 33,768 | 3,482 | 46,524 |
| Redonda (British West Indies) | 1,729 | 10,498 | ........ | ........ | ........ | ........ |
| Spain | 3,305 | 19,136 | 1,370 | 7,295 | 1,300 | 7,592 |
| Sweden | 2,929 | 6,279 | ........ | ........ | ........ | ........ |
| Tunis | 455,197 | 1,582,165 | 521,731 | 1,812,493 | 796,000 | 2,304,400 |
| United Kingdom | 59 | 423 | ........ | ........ | ........ | ........ |
| United States | 1,904,418 | 6,580,875 | 1,978,345 | 6,763,403 | 2,114,252 | 8,579,437 |

[a] Value not reported.

[b] Statistics not yet available.

# SALT AND BROMINE.

By W. C. Phalen.

## SALT.

### PRODUCTION.

In 1907 the quantity of salt produced in the United States was 29,704,128 barrels of 280 pounds, valued at $7,439,551; in 1906 the production reported was 28,172,380 barrels, valued at $6,658,350—an increased output for 1907 of 1,531,748 barrels in quantity and of $781,201 in value.

These quantities expressed on a tonnage basis represent an output of 3,944,133 short tons in 1906, and of 4,158,578 short tons in 1907, an increase during 1907 of 214,445 short tons.

In 1906 the average net value was 23.634 cents per barrel, or $1.69 per short ton; in 1907 the average net value was 25.046 cents per barrel, or $1.79 per short ton, an increase for 1907 of 1.412 cents per barrel, or 10 cents per ton.

The following table shows the quantity and value of salt reported as produced in the United States from 1893 to 1907:

*Production and value of salt in the United States, 1893–1907.*

| | | |
|---|---|---|
| 1893..barrels.. | 11, 897, 208 | $4, 154, 668 |
| 1894....do.... | 12, 968, 417 | 4, 739, 285 |
| 1895....do.... | 13, 669, 649 | 4, 423, 084 |
| 1896....do.... | 13, 850, 726 | 4, 040, 839 |
| 1897....do.... | 15, 973, 202 | 4, 920, 020 |
| 1898....do.... | 17, 612, 634 | 6, 212, 554 |
| 1899....do.... | 19, 708, 614 | 6, 867, 467 |
| 1900....do.... | 20, 869, 342 | 6, 944, 603 |
| 1901..barrels.. | 20, 566, 661 | $6, 617, 449 |
| 1902....do.... | 23, 849, 231 | 5, 668, 636 |
| 1903....do.... | 18, 968, 089 | 5, 286, 988 |
| 1904....do.... | 22, 030, 002 | 6, 021, 222 |
| 1905....do.... | 25, 966, 122 | 6, 095, 922 |
| 1906....do.... | 28, 172, 380 | 6, 658, 350 |
| 1907....do.... | 29, 704, 128 | 7, 439, 551 |

### PRODUCTION OF SALT BY GRADES AND STATES.

*Production by grades.*—For convenience salt is classified according to the grades by which it is sold by the producer, the grades being determined by the amount of refining, the methods employed in refining, and the purposes for which the salt is used. These grades are: "Table and dairy," "common fine," "common coarse," "packers," "solar," "rock," "milling," "brine," and "other grades." The "table and dairy" salt includes extra fine and fancy grades prepared for family use, and all grades artificially dried, used for butter and cheese making, and such special brands. Under "common fine" salt are included all other grades of fine salt of first quality not artificially dried, such as those known to the trade as "C. F.," "No. 1 F," "anthracite," etc. "Common coarse" salt includes all grades coarser than "common fine" made by artificial heat, such as "steam coarse," "No. 1 coarse," "pan solar," "G. A.," "Liverpool ground," "C. C.," etc. By "packers" salt is meant those grades prepared for the purpose of curing fish, meats, etc. "Coarse solar" includes all coarse salt made by solar evaporation. "Rock" salt includes all salt mined and shipped without special preparation. "Mill" salt is that used in gold and silver mills, and "other grades" includes all low-grade or No. 2 salt used in salting cattle and for fertilizers, track purposes, etc. "Brine" includes all salt liquor used in the manufacture of soda ash, sodium bicarbonate, sodium hydrate (caustic soda), and other sodium salts or brine sold without being evaporated to dryness.

The following table shows the salt production of the United States by grades during the last five years:

*Production of salt, by grades, in the United States, 1903–1907, in barrels.*

| Year. | Table and dairy. | Common fine. | Common coarse. | Packers. | Solar. |
|---|---|---|---|---|---|
| 1903 | 2,441,908 | 6,351,855 | 1,829,460 | 270,170 | 1,743,101 |
| 1904 | 2,508,408 | 6,819,109 | 2,604,981 | 96,130 | 1,189,393 |
| 1905 | 2,380,808 | 6,818,690 | 2,724,769 | 327,192 | 903,143 |
| 1906 | 2,923,044 | 6,483,937 | 2,550,209 | 452,490 | 1,080,591 |
| 1907 | 3,537,157 | 7,684,638 | 2,055,054 | 422,324 | 862,929 |

| Year. | Rock. | Milling. | Other grades. | Brine. | Total production. | Total value. |
|---|---|---|---|---|---|---|
| 1903 | 3,175,521 | 37,657 | 3,118,417 | (a) | 18,968,089 | $5,286,988 |
| 1904 | 4,369,141 | 349,421 | 86,469 | 4,006,950 | 22,030,002 | 6,021,222 |
| 1905 | 4,733,765 | .......... | 207,824 | 7,869,931 | 25,966,122 | 6,095,922 |
| 1906 | 4,873,526 | .......... | 234,903 | 9,573,680 | 28,172,380 | 6,658,350 |
| 1907 | 5,809,328 | .......... | 110,227 | 9,222,471 | 29,704,128 | 7,439,551 |

[a] Included under "Other grades."

From this table it is evident that the finer grades have shown a substantial increase in quantity from 1906 to 1907, while the coarser grades, except rock salt, have decreased in quantity.

*Production by States.*—The following table gives the production and value of the salt produced in the United States from 1904 to 1907, inclusive, by States:

*Production and value of salt, 1904–1907, by States, in barrels.*

| State. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| New York | 8,600,656 | $2,101,568 | 8,359,121 | $2,167,931 | 8,978,630 | $2,098,686 | 9,642,178 | $2,335,150 |
| Michigan | 5,425,904 | 1,579,206 | 9,492,173 | 1,851,332 | 9,936,802 | 2,018,760 | 10,786,630 | 2,062,357 |
| Ohio | 2,455,829 | 478,523 | 2,526,558 | 565,946 | 3,236,785 | 789,237 | 3,851,243 | 979,078 |
| Kansas | 2,161,819 | 717,101 | 2,098,585 | 576,139 | 2,198,837 | 681,022 | 2,667,459 | 962,334 |
| Louisiana | 1,095,850 | 320,000 | 1,055,186 | 303,507 | 1,179,528 | 268,005 | 1,157,621 | 226,892 |
| California | 821,557 | 205,435 | 664,099 | 188,330 | 806,788 | 291,528 | 626,693 | 302,940 |
| West Virginia | 575,000 | 66,470 | 202,151 | 74,063 | 200,055 | 57,584 | 156,147 | 76,527 |
| Texas | 376,695 | 149,246 | 444,832 | 142,993 | 360,733 | 170,559 | 356,086 | 226,540 |
| Utah | 253,829 | 321,301 | 177,342 | 135,465 | 262,212 | 169,635 | 345,557 | 199,779 |
| Idaho | (a) | (a) | (a) | (a) | 1,574 | 1,867 | 1,600 | 2,040 |
| Nevada | (a) | (a) | (a) | (a) | 11,249 | 6,420 | 6,457 | 3,654 |
| Oklahoma | (a) | (a) | (a) | (a) | 9,893 | 4,965 | 800 | 910 |
| Other States | 262,863 | 82,372 | [b] 946,075 | 90,216 | [c] 989,294 | 100,082 | [d] 105,657 | 61,350 |
| Total | 22,030,002 | 6,021,222 | 25,966,122 | 6,095,922 | 28,172,380 | 6,658,350 | 29,704,128 | 7,439,551 |

[a] Included in other States.

[b] Virginia, Pennsylvania, Oklahoma, Nevada, New Mexico, Massachusetts, and Idaho.

[c] Includes Virginia, Pennsylvania. New Mexico, and Massachusetts.

[d] Includes Pennsylvania, New Mexico, and Massachusetts.

When value of product alone is considered, this table shows that New York still occupies the leading position in the salt industry. In and since 1905 Michigan has produced a larger quantity of salt than New York, but the average net price in the former State is so much less than in New York that the difference in production is not sufficient to compensate for the difference in value per barrel. So far as both production and value go, the nine leading States maintained in 1907 the same order as in 1906. Louisiana in both years produced more salt than California, but the output from the latter State had a greater value.

It will be noted that in increase of production the year 1907 did not keep pace with the other years since 1903, but in spite of that the total value showed a substantial increase, owing to the higher prices received. There was a healthy growth in the industry in New York, Michigan, and Kansas. Utah just about held her own, the increase in quantity for 1907 being practically the same as in 1906. Though there was a larger production in Ohio, the increase did not equal that reported for 1906. In California, West Virginia, Texas, Louisiana, Nevada, and Oklahoma, there was a decreased production, coupled with an advance in value in the first three States mentioned. In general it may be said that the increase in the value is due to higher price of labor and increased cost of supplies. In California, however, various local factors have combined to produce a shortage, and thus to raise prices. These factors are considered in the description of the salt industry in that State.

It was reported[a] that an understanding has been reached between one of the leading salt producers of New York and certain independent manufacturers regarding the future regulation of the market for evaporated salt. This action was taken on account of the higher cost of labor and supplies as well as on account of overproduction. As a result prices were advanced from 50 cents to $1 per ton from the low figures which prevailed in the early fall, when sharp cutting in prices was in progress. Notwithstanding this advance, quotations during October were still below the top level of the preceding year. Incidentally a policy of retrenchment was inaugurated and various establishments reduced their working forces. As is customary during the fall months, the demand for salt showed a falling off, which applied more particularly to rock salt. The consumption of this grade of salt during 1907 was about 25 per cent higher than in 1906. The demand for crude and evaporated salt was not sufficient to keep pace with the volume of production.

The comparatively small average price per barrel in some States during 1907, as in the two preceding years, is accounted for by the large quantity of brine used in chemical works which is not concentrated into salt. The average value of the dry salt obtained from this brine, according to the principal producers, is about 5 cents per barrel.

*Production by States and grades.*—The following table shows the grades of salt produced in the different States. Brine and other grades are combined in order to conceal individual production of dry salt obtained from brine.

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[a] Journal of Commerce as cited in Eng. and Min. Jour., October 19, 1907.

*Production of salt, by States and grades, in the United States in 1907, in barrels.*

| State. | Table and dairy. | | Common fine. | | Common coarse. | | Packers. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| California | 233,507 | $145,001 | | | 12,293 | $9,169 | 70,479 | $24,669 |
| Idaho | 100 | 240 | 214 | $500 | 107 | 150 | | |
| Kansas | 121,727 | 90,245 | 1,297,907 | 613,295 | | | | |
| Louisiana | | | | | | | | |
| Michigan | 657,509 | 392,641 | 3,601,270 | 914,154 | 1,743,840 | 471,378 | 119,459 | 48,455 |
| Nevada | | | | | 6,457 | 3,654 | | |
| New York | 1,219,357 | 658,825 | 1,118,164 | 426,645 | 162,078 | 65,345 | 82,057 | 32,464 |
| Ohio | 1,110,678 | 463,986 | 1,170,043 | 338,073 | 127,443 | 43,058 | 150,279 | 68,187 |
| Oklahoma | | | 786 | 900 | | | | |
| Texas | 78,000 | 57,420 | 262,357 | 159,561 | 2,757 | 1,314 | | |
| Utah | 68,279 | 98,170 | 25,750 | 19,100 | 79 | 80 | 50 | 81 |
| West Virginia | 48,000 | 27,232 | 108,147 | 49,295 | | | | |
| Other States[a] | | | 100,000 | 60,000 | | | | |
| Total | 3,537,157 | 1,933,760 | 7,684,638 | 2,581,323 | 2,055,054 | 594,148 | 422,324 | 173,856 |

| State. | Solar. | | Rock. | | Other and brine. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| California | 300,550 | $117,997 | 7,857 | $5,150 | 2,007 | $954 | 626,693 | $302,940 |
| Idaho | | | 1,179 | 1,350 | | | 1,600 | 2,040 |
| Kansas | | | 1,246,536 | 258,344 | 1,289 | 450 | 2,667,459 | 962,334 |
| Louisiana | | | 1,157,621 | 226,892 | | | 1,157,621 | 226,892 |
| Michigan | | | | | 4,664,552 | 235,729 | 10,786,630 | 2,062,357 |
| Nevada | | | | | | | 6,457 | 3,654 |
| New York | 415,079 | 145,586 | 3,201,507 | 827,196 | 3,353,036 | 179,089 | 9,642,178 | 2,335,150 |
| Ohio | | | | | 1,292,800 | 65,774 | 3,851,243 | 979,078 |
| Oklahoma | | | | | 14 | 10 | 800 | 910 |
| Texas | 12,086 | 7,868 | | | 886 | 377 | 356,086 | 226,540 |
| Utah | 134,014 | 40,795 | 104,628 | 28,099 | 12,757 | 13,454 | 345,557 | 199,779 |
| West Virginia | | | | | | | 156,147 | 76,527 |
| Other States[a] | 300 | 600 | | | 5,357 | 750 | 105,657 | 61,350 |
| Total | 862,929 | 312,846 | 5,809,328 | 1,347,031 | 9,332,698 | 496,587 | 29,704,128 | 7,439,551 |

[a] Includes Massachusetts, New Mexico, and Pennsylvania.

## THE SALT INDUSTRY BY STATES.

The tables show that salt is produced in the United States on a commercial scale in fourteen States and one Territory, namely, California, Idaho, Kansas, Louisiana, Massachusetts, Michigan, Nevada, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, Utah, and West Virginia. A description of the conditions of the industry in these States and Territory follows:

*California.*—California ranked fifth as a salt-producing State in 1907, with an output of 626,693 barrels or 87,737 short tons, valued at $302,940, an average of 48 cents per barrel as compared with 36 cents per barrel in 1906, or $3.45 per ton as compared with $2.58 per ton in 1906. This is a decrease of 180,095 barrels or 25,213 short tons in quantity. The value, however, increased $11,412 over the value in 1906. The reasons for this increase are as follows: In 1907, as in 1906, the salt industry in California was disturbed by excessive rains and floods. Practically all the salt in the State is produced in Alameda, San Mateo, San Bernardino, San Diego, and Los Angeles counties, and by far the greater part of the production is obtained by solar evaporation, which consists in taking the water from ocean or bay or tributary streams and transferring it from one vat to another until sufficient water is evaporated and the salt is crystallized out, when it is drained and piled into heaps containing quantities varying from 100 to 2,000 tons. During the winter of 1907 many of the principal producers, especially in San Mateo and Alameda counties, reported excessive losses, due to breaks in the levees during the high tides. The water is reported to have washed away a great deal of the "pickle," and also to have dissolved considerable salt in the piles. It is further reported that the waters in San Francisco Bay at no time during the summer contained more than 7 per cent saline matter in solution, and in some cases not more than one-third the usual crop was obtained. Barely enough salt has been made by some firms to last into July of the current year, when new salt must be put upon the market—a very unusual condition of affairs. The floods, with the consequent shortage in production and increased cost in cleansing the pans and the increased cost of labor and fuel, where fuel is used, have caused an abnormal increase in the price, which at times has been quoted as high as $4 a ton.

As in 1906, there was a tendency in 1907 toward consolidation in the California salt industry. Among the new operations the Crystal Salt Company, with works at Amboy, San Bernardino County, has installed a plant to make salt from brine.

The localities of output in California were Newark, Alvarado, Mount Eden, and Russells (Haywards), in Alameda County; Redwood City and Leslie, in San Mateo County; Long Beach, in Los Angeles County; near San Diego, in San Diego County; and in Marin and Colusa counties.

*Idaho.*—The production reported from Idaho in 1907 amounted to 1,600 barrels, valued at $2,040, as compared with a production in 1906 of 1,574 barrels, valued at $1,867. The industry is, therefore, small and practically stationary. The production came from Bear Lake and Bannock counties, in the southeastern part of the State, near the State line. The salt is produced by a few small operators, by the open-pan process, in which the heat is applied directly.

*Kansas.*—Kansas ranked fourth in the list of salt-producing States in 1907, maintaining the same relative position that it had in 1906. The production for the year was 2,667,459 barrels or 373,444 short tons, valued at $962,334. In comparison with the output in 1906 of 2,198,837 barrels or 307,837 short tons, valued at $681,022, this is an increase for the year 1907 of 468,622 barrels or 65,607 short tons in quantity and of $281,312 in value. The average price in 1907 was 36 cents per barrel, or $2.58 per ton, a considerable increase over the corresponding prices for 1906, which were, respectively, 31 cents per barrel and $2.21 per ton.

The localities where salt is produced commercially in Kansas are Hutchinson, Reno County; Lyons and Sterling, Rice County; Kanopolis and Ellsworth, Ellsworth County; Anthony, Harper County; and Kingman, Kingman County. Most of the firms engaged in the salt industry use the grainer and open-pan processes, employing steam in the evaporation; but a few manufacturers apply the heat directly.

*Louisiana.*—The rock salt mined in Louisiana is from Iberia Parish, the output in 1907 being 1,157,621 barrels or 162,067 short tons, valued at $226,892, as compared with 1,179,528 barrels or 165,134 tons in 1906, valued at $268,005—a decrease in 1907 of 21,907 barrels or 3,067 short tons in quantity and of $41,113 in value.

For detailed descriptions of the Louisiana salt deposits the reader should consult the works cited in the bibliography at the end of the chapter.

*Massachusetts.*—The small quantity of salt produced in Massachusetts is obtained by evaporation of sea water near Buzzards Bay, but the industry was discontinued in 1907.

*Michigan.*—For the last few years Michigan has produced a greater quantity of salt than any other State in the Union, but the value of the output has been less than that of the somewhat smaller quantity produced in New York. In 1907 the output of Michigan was 10,786,630 barrels or 1,510,128 short tons, valued at $2,062,357; in 1906 the quantity produced was 9,936,802 barrels or 1,391,522 short tons, valued at $2,018,760; an increase in 1907 of 849,828 barrels or 118,606 short tons in quantity and of $43,597 in value.

The deposits of this State are beds of rock salt exploited by means of wells. The artificial brine is converted into salt mostly by the use of steam in the vacuum-pan and grainer processes, or is used directly by chemical works in the manufacture of sodium salts. The commercial localities are Ludington, Mason County; Saginaw, Carrollton, and St. Charles, Saginaw County; Manistee, Filer City, and Eastlake, Manistee County; Marine City, St. Clair, and Port Huron, St. Clair County; Wyandotte, Ecorse, and near Detroit, in Wayne County; Midland, Midland County; and Bay City, Bay County.

*Nevada.*—The commercial output of salt in Nevada is procured from Washoe and Churchill counties, and is obtained from brine by solar evaporation. During the year the old vats at Buffalo Salt Works, Washoe County, were dug out and repairs were made to the works. It is reported that Messrs. William Sulzer and R. W. Wylie are developing a deposit of salt at Sandy Springs, 22 miles from Fallon, Churchill County.

*New Mexico.*—Torrance County furnishes the only commercial salt reported from this Territory. The salt is obtained from brine by solar evaporation.

*New York.*—This State ranks first in the value of salt production but second in the quantity of output, being exceeded in the latter respect by Michigan. In 1907 the production of New York was 9,642,178 barrels or 1,349,905 short tons, valued at $2,335,150; and in 1906 it was 8,978,630 barrels or 1,257,008 short tons, valued at $2,098,686—an increase in 1907 of 663,548 barrels or 92,897 short tons in quantity and of $236,464 in value.

The salt produced in New York State[a] includes rock salt and the various varieties of brine salt known as "coarse solar," "common fine," "table," "agricultural," and "packers" salt. In addition to the salt that is used as such, the figures of production of the State include the value of the brine that is converted into commercial soda products, as, for instance, by the Solvay Process Company at Solvay, near Syracuse.

Solar salt is made almost entirely in Onondaga County, and Syracuse has long been the center of the industry, which dates back more than one hundred years. The natural brine from which the salt is obtained contains from 17 to 20 per cent sodium chloride. This appears to be stored in glacial gravels and is thought to have been formed by the circulation of underground waters through saline beds. Most of the wells are located on the Onondaga Reservation, under State control, and the brine is supplied to individual operators at a fixed charge. Manufacturers of brine salt in other parts of the State obtain their supply from wells driven into the rock salt; water is introduced into the wells and then pumped up after nearly complete saturation. By this means a brine carrying about 25 per cent sodium chloride is obtained. The Tompkins County salt is thus obtained from deposits exceeding 2,000 feet in depth.

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[a] Newland, D. H., Report on the mining and quarry industry: Bull. New York State Museum No. 112, 1907, pp. 54-55.

A description of the technology of salt mining in Tompkins County, as practiced by the Remington Salt Company, has been recently given by Charles S. Palmer,[a] and is in part as follows:

> The salt beds from which the supply is obtained are two in number, each about 40 feet thick, separated from each other by a layer of slate 8 feet thick, and lying about 2,000 feet in depth below the level of Lake Cayuga. The borings (which were driven with frames much resembling the common oil derricks) carry a double-walled casing. In the outer jacket of this casing (which is 8 or 10 inches in diameter) water is forced down under pressure to the top of the upper salt bed. The inner tube of the casing (which is 3½ inches in diameter) extends nearly to the bottom of the lower salt stratum. Thus the salt is dissolved by the water from the outer jacket and a saturated solution is formed; this is forced up the center tube from the bottom of the deposit. The water (taken from Lake Cayuga) falls to the top of the salt bed, accumulates a large subterranean lake of strong brine, and gradually sinks, to be raised as stated. This brine has a specific gravity of 1.3, and consists of one-third salt and two-thirds water. The hydrostatic pressure of the water column in the outer jacket is equal only to about two-thirds of the pressure in the inner cylinder of the casing, so that the brine practically has to be raised through the difference (700 feet) by extra pressure carried by the water forced down through the outer casing, for the salt deposit is in a closed cavity.
>
> The strong brine when raised to the surface is led directly to large settling and storage tanks high on the hillside. Here the brine is clarified by the addition of a little lime, which precipitates some impurity as insoluble sediment. These brine tanks are also supplied with steam coils (supplied with exhaust steam from the power house as described) which heats the brine to about 90° F. before it is concentrated in the mill proper.
>
> In the mill the brine flows, by gravity, from the storage tanks to simple 30-ton vacuum pans; these contain in the lower part 1,700 (4 foot by 2 inch) pipes, carrying exhaust steam. The vacuum is maintained by pumps actuated by live steam.
>
> The clarified and warmed brine is fed in at the top of the vacuum pan in a constant stream, is concentrated, and sinks to the bottom of the pan as a thick mush of fine crystals. This salt mush is raised by a bucket elevator to the top of the mill, where it is dried in centrifugals (1,200 pounds of salt at a charge). It is then dropped into hoppers which convey it to a "kiln drier"—a rotating iron cylinder supplied with steam coils and a current of dry air. After this the salt is passed through a 20-mesh screen, the coarse part being a very small fraction. The salt is prepared in quality of table fineness, most of which will pass a 40-mesh opening. It is quoted at $3 or $4 per short ton, plus the cost of packing in bag or barrel. The waste residue from the centrifugals is thrown into the lake, as it carries no valuable bittern (bromide or iodide) and is not suitable for being used over again.
>
> The plant is provided not only with the vacuum-pan equipment, but also with shallow open-evaporation tanks of wood carrying 6 or 8 inch steam pipes (the Michigan system). In this open-tank system, the size of the crystal grain can be controlled, and various grades are made depending on the size of the grain; but in the centrifugals the size of the grain can not be controlled, and it often varies considerably, without warning and under apparently the same circumstances. In general, the finer-grained grades are made in the pans.

The localities producing in 1907 were the Onondaga district in Onondaga County, near Syracuse; Ithaca, Tompkins County; Watkins Glen and Ludlowville, Schuyler County; Perry, Rock Glen, Silver Springs, and Warsaw, Wyoming County; Le Roy, Genesee County; Retsof, Cuylerville, and Piffard, Livingston County.

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[a] Eng. and Min. Jour., June 30, 1906.

*Ohio.*—Ohio ranked third in the value of salt production in 1907, maintaining the same relative position that it has had for several years. The production for 1907 was 3,851,243 barrels, or 539,174 short tons, valued at $979,078. This output, compared with 3,236,785 barrels, or 453,150 short tons, valued at $789,237, in 1906, shows an increase in 1907 of 614,458 barrels, or 86,024 short tons, in quantity and of $189,841 in value.

A very complete description of the salt deposits, together with their historical development and present modes of working, has been recently published by J. A. Bownocker,[a] from which the following notes have been compiled.

The salt production in Ohio is confined to the eastern part of the State, and comes from two districts—the northeastern district, comprising Cuyahoga, Medina, Summit, and Wayne counties, and the southeastern district, in which are included Meigs and Morgan counties.

In southeastern Ohio, Meigs County is by far the more important producer, having produced more than all the other counties in this part of the State combined. Pomeroy is the center of the industry.

The surface rocks in the Ohio Valley near Pomeroy lie at the summit of the Conemaugh formation, formerly known as the Lower Barren Coal Measures. The depth of the wells in the region has undergone great variation. At first they were shallow but were later extended to greater depths as the supply of brine became exhausted near the surface. When the supply from these deeper wells proved inadequate they were sunk to greater depths.

When drilling first began in Ohio the water in the wells is said to have risen nearly to their heads, and in some cases to have actually overflowed. As pumping progressed the reservoirs of brine were lowered, and at the same time the tubing was extended deeper into the wells, the tubing following the brine in its descent. The density of the brine has increased in the direction of the dip of the rocks—that is, to the southeast. The quantity of brine that has been taken from these rocks is enormous and is much more than the capacity of the rocks at any one time. This great excess has doubtless been derived from surrounding territory. The brine-bearing strata dip toward Pomeroy from the northwest, and as the brine has been removed from the wells the supply has been renewed from the rocks lying at higher levels to the northwest. The brine was doubtless once a part of the ocean, and as the sand or gravel now comprising the salt-bearing rocks was deposited on the ocean floor, sea water filled the spaces between the grains and pebbles, and has remained since in that position. It must be borne in mind, however, that the Pomeroy brines were probably very near the shore, perhaps within a land-locked sea, and hence might vary considerably from those in the open ocean. This fact explains the presence of the relatively large quantities of bromides and iodides, since these substances are contained in certain marine plants. It is possible that conditions were very favorable for these plants in the early sea in the vicinity of Pomeroy.

In northeastern Ohio the salt industry is of recent origin, but its development has been rapid. Though plants are established in four counties, namely, Cuyahoga, Summit, Medina, and Wayne, the salt deposits are not confined to this territory. The salt-bearing beds are known to extend as far east as Cortland, Trumbull County, but the southern limit of the salt deposits is unknown, from the fact that the salt-bearing beds lie very deep and have not been reached by drill. The western limit also is not definitely known, though it is known not to extend as far as Sandusky.

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[a] Bull. Geol. Survey Ohio No. 8, 1906.

For the description of the technology connected with the salt industry, the reader is referred to the publication cited above and to the bibliography at the end of this chapter.

*Oklahoma.*—The small production from Oklahoma comes from near Ferguson, Blaine County.

*Pennsylvania.*—The output from Pennsylvania was from Pittsburg, Allegheny County.

*Texas.*—The output of salt reported from Texas in 1907 increased in value but decreased in quantity. In 1906 the output was 360,733 barrels or 50,502 short tons, valued at $170,559; in 1907 it was 356,086 barrels or 49,852 short tons, valued at $226,540—a decrease for 1907 of 4,647 barrels or 650 short tons in quantity, and an increase of $55,981 in value. The average price was 64 cents per barrel or $4.54 per ton in 1907, as compared with 47 cents per barrel or $3.38 per ton in 1906.

The commercially producing localities are Grand Saline, Van Zandt County; Colorado, Mitchell County; Palestine, Anderson County; and Grand Falls, Crane County. The output was obtained from brine by simple solar evaporation or by grainer process.

There are many salt lakes or salines throughout Texas from which much salt is taken annually by ranchmen. Some of this salt yields the owner of the lake a certain revenue, but much of it is to be had simply for the labor of getting it out. Although no report of this output reaches the United States Geological Survey, it is known that large quantities are taken out annually. Such salt lakes dry up after rains and leave a crust of salt varying from one-fourth to 1½ inches thick, which is raked up, loaded on wagons, and carted away. A large quantity of such salt annually goes to waste simply because there are no facilities for marketing it.

*Utah.*—There was an increase in both quantity and value of the salt produced in Utah in 1907. The output in 1906 was 262,212 barrels or 36,710 short tons, valued at $169,635; in 1907 the output was 345,557 barrels or 48,378 short tons, valued at $199,779—an increase in 1907 of 83,345 barrels or 11,668 short tons in quantity and of $30,144 in value.

The salt is obtained from brine by solar evaporation, chiefly in the neighborhood of Great Salt Lake, Salt Lake County. Brine is also produced at Nephi City, Juab County. Other salt-producing localities are near Gunnison, Sanpete County; in Sevier County; in Millard County; and at Withee Junction, Weber County.

*Virginia.*—No production of salt was reported from this State for the year 1907. Salt was formerly produced from brine in Virginia, but the brine has recently been used entirely for chemical purposes. Salt is obtained at Saltville, Smyth County, but the Mathiesen Alkali Works have recently discontinued selling salt and have concentrated their attention on other articles. For years the salt produced at Saltville has been favorably known throughout the Southern States and used in immense quantities. It is intended at an early date to complete a plant for a modern vacuum-pan process of manufacture, which will enable the Mathiesen Company to resume the salt business under more favorable circumstances.[a]

*West Virginia.*—The salt output from this State in 1907 came from near Malden, Kanawha County, and Hartford and Mason, Mason County.

### DOMESTIC CONSUMPTION.

The following table shows the increase in the proportion of salt produced in the United States entering into domestic consumption. Of the total consumption of salt in the United States the quantity of domestic production used has increased from 63.5 per cent in 1880 to 96.6 per cent in 1907, and the consumption of salt imported into the United States has decreased from 36.5 per cent of the total in 1880 to 3.4 per cent in 1907, this being 0.9 per cent less than in 1906. The actual consumption in 1907 was 30,546,967 barrels, while in 1880 the actual consumption was but 9,384,263 barrels. The production in the United States in 1880 was 5,961,060 barrels, and the imports amounted to 3,427,639 barrels. In 1907 the production had increased to 29,704,128 barrels and the imports had decreased to 1,062,851 barrels, which importation was considerably less than that of 1906.

*Supply of salt for domestic consumption, 1880–1906, in barrels.*

| Source. | 1880. | 1890. | 1900. | 1906. | 1907. |
|---|---|---|---|---|---|
| Domestic production | 5,961,060 | 8,876,991 | 20,869,342 | 28,172,380 | 29,704,128 |
| Imports | 3,427,639 | 1,838,024 | 1,427,921 | 1,247,367 | 1,062,851 |
| Total | 9,388,699 | 10,715,015 | 22,297,263 | 29,419,747 | 30,766,979 |
| Exports | 4,436 | 17,597 | 53,650 | 242,774 | 220,012 |
| Domestic consumption | 9,384,263 | 10,697,418 | 22,243,613 | 29,176,973 | 30,546,967 |
| Increase over preceding year | | 877,610 | 1,274,634 | 2,304,273 | 1,369,994 |
| Percentage of imports to total consumption | 36.5 | 17.2 | 6.4 | 4.3 | 3.4 |

### IMPORTS.

In 1894 salt was placed on the free list and importations increased to 434,155,708 pounds in 1894 and to 520,411,822 pounds in 1896. In 1897 salt was again made dutiable, and salt in bags, barrels, or other packages is subject to a duty of 12 cents per 100 pounds (33.6 cents per barrel) and salt in bulk is taxed 8 cents per 100 pounds (22.4 cents per barrel). The duty on imported salt in bond used in curing fish taken by licensed vessels engaged in fishing and in curing fish on the navigable waters of the United States or on salt used in curing meats for export may be remitted.

According to figures obtained from the Bureau of Statistics of the Department of Commerce and Labor the quantity and value of the salt imported and entered for consumption in the United States in the last five years is as follows:

*Salt imported and entered for consumption in the United States, 1903–1907, in pounds.*

| Year. | In bags, barrels, and other packages. | | In bulk. | | For the purpose of curing fish. | | Total quantity. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| 1903 | 72,838,011 | $259,029 | 147,635,246 | $134,714 | 107,487,450 | $102,205 | 327,960,707 | $495,948 |
| 1904 | 69,657,850 | 209,509 | 143,903,175 | 135,408 | 118,718,456 | 122,837 | 332,279,481 | 467,754 |
| 1905 | 73,252,959 | 247,853 | 155,091,301 | 153,914 | 93,972,951 | 90,422 | 322,317,211 | 492,189 |
| 1906 | 74,228,878 | 257,592 | 159,674,675 | 149,944 | 115,359,107 | 101,326 | 349,262,660 | 508,862 |
| 1907 | 74,762,435 | 242,377 | 115,826,979 | 108,166 | 107,008,980 | 100,739 | 297,598,394 | 451,282 |

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[a] Manufacturers' Record, March 5, 1908.

From the table it is evident that the imports of salt into the country fell off considerably in 1907; the figures for the year are lower than those for any year of which the Survey has record. In other words, the domestic production is more than ever before nearly able to meet the domestic consumption. The chief decrease is noted in the quantity and value of salt imported in bulk, but there is also a falling off from 1906 in the salt imported for the fisheries industry. There was a slight increase in the quantity of high grade salt imported.

The imports came from the United Kingdom, Italy, British West Indies, and Spain, named in the order of importance. From these four sources over 90 per cent of both quantity and value of the imports were derived.

## EXPORTS.

The exports of salt of domestic production from the United States from 1903 to 1907 is shown as follows:

*Salt of domestic production exported from the United States, 1903-1907.*

| | | | |
|---|---|---|---|
| 1903 | pounds | 25,499,630 | $95,570 |
| 1904 | do | 27,928,090 | 113,625 |
| 1905 | do | 68,475,356 | 239,223 |
| 1906 | pounds | 67,976,581 | $274,627 |
| 1907 | do | 61,603,422 | 232,895 |

The exports of salt have increased greatly since the early part of the present decade. In 1907 there was a slight decrease from the exports in 1906. Most of this salt went to Cuba, Canada, Mexico, and Panama.

## WORLD'S PRODUCTION.

In the following table the statistics of salt production in the principal salt-producing countries of the world from 1901 to 1906 are shown as far as statistics are available. The production of Turkey is not included. The industry in that country, as in Austria-Hungary, is a Government monopoly, with no statistics of production published. No statistics are available from Russia since 1903.

*The world's salt production, 1901-1906, in short tons.*

| Year. | United States. | | United Kingdom. | | France.[a] | | German Empire. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1901 | 2,877,932 | $6,617,449 | 1,997,566 | $2,864,950 | 1,014,093 | $2,012,800 | 1,724,747 | $5,064,500 |
| 1902 | 3,339,891 | 5,668,636 | 2,121,147 | 2,805,838 | 982,479 | 2,605,800 | 1,745,226 | 4,992,600 |
| 1903 | 2,655,533 | 5,286,988 | 2,113,431 | 2,967,676 | 1,096,017 | 3,036,930 | 1,867,208 | 4,587,767 |
| 1904 | 3,084,200 | 6,021,222 | 2,118,629 | 2,900,375 | 1,292,567 | 3,650,052 | 1,875,733 | 4,693,122 |
| 1905 | 3,635,257 | 6,095,922 | 2,116,099 | 2,707,622 | 1,275,361 | 3,594,818 | 1,959,401 | 4,829,496 |
| 1906 | 3,944,133 | 6,658,350 | 2,201,293 | 2,900,983 | 1,496,923 | 4,198,329 | 2,059,096 | 5,000,823 |

| Year. | Japan. | | Italy. | | Austria-Hungary.[b] | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1901 | 761,575 | $4,459,245 | 479,706 | $668,982 | 569,725 | $15,556,431 |
| 1902 | 684,330 | 4,415,145 | 506,401 | 711,400 | 575,936 | 16,071,930 |
| 1903 | 724,750 | 4,692,539 | 538,480 | 717,466 | 630,078 | 16,180,748 |
| 1904 | 773,776 | 4,852,049 | 511,827 | 713,596 | 595,335 | 16,024,783 |
| 1905 | (c) | (c) | 482,475 | 714,859 | 609,572 | 17,115,539 |
| 1906 | (c) | (c) | 586,424 | 1,119,786 | [d] 414,465 | [d] 9,717,164 |

[a] Includes product of Algeria.
[b] Government monopoly.
[c] Production and value in 1904 used in making up the total for the world's production in 1905 and 1906.
[d] Hungary not included.

*The world's salt production, 1901–1906, in short tons*—Continued.

| Year. | Russia. | | Spain. | | India. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1901.......... | 1,880,438 | $3,591,973 | 380,363 | $599,934 | 1,234,839 | $1,821,764 |
| 1902.......... | 2,035,969 | 3,964,162 | 470,057 | 707,424 | 1,231,058 | 2,481,357 |
| 1903.......... | 1,828,646 | 3,652,074 | 471,116 | 670,247 | 1,002,221 | 2,420,260 |
| 1904.......... | (a) | (a) | 599,292 | 738,348 | 1,236,702 | 2,008,930 |
| 1905.......... | (a) | (a) | 543,931 | 736,074 | 1,336 682 | 1,981,293 |
| 1906.......... | (a) | (a) | 597,422 | 782,407 | 1,296,674 | 1,916,092 |

| Year. | Canada. | | Other countries.[b] | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1901.......... | 59,428 | $262,328 | 541,613 | $2,463,670 | 13,522,025 | $45,989,867 |
| 1902.......... | 63,056 | 288,581 | 125,467 | 970,522 | 13,880,017 | 45,613,395 |
| 1903.......... | 62,452 | 297,517 | 477,000 | 1,106,000 | 13,674,341 | 45,858,300 |
| 1904.......... | 68,777 | 318,628 | 584,000 | 1,543,000 | 14,569,464 | 47,537,508 |
| 1905.......... | 67,340 | 320,858 | 442,086 | 1,841,926 | 15,071,226 | 48,442,530 |
| 1906.......... | 72,697 | 342,315 | [c] 69,004 | 45,548 | 15,340,553 | 41,185,910 |

[a] Production and value in 1903 used in making up total for world's production in 1904, 1905, and 1906.
[b] Probably 500,000 tons should be added annually for countries not furnishing statistics.
[c] Tunis.

## BROMINE.

The bromine industry in the United States is centered in Michigan, Ohio, Pennsylvania, and West Virginia, named according to their relative importance, and the production from these four States is given in the following table:

*Production and value of bromine, 1880–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1880......pounds.. | 404,690 | ......... | 1895.......pounds.. | 517,421 | $134,343 |
| 1883........do.... | 301,000 | ......... | 1896.........do.... | 546,580 | 144,501 |
| 1884........do.... | 281,100 | $67,464 | 1897.........do.... | 487,149 | 129,094 |
| 1885........do.... | 310,000 | 89,900 | 1898.........do.... | 486,979 | 126,614 |
| 1886........do.... | 428,334 | 141,350 | 1899.........do.... | 433,004 | 108,251 |
| 1887........do.... | 199,087 | 61,717 | 1900.........do.... | 521,444 | 140,790 |
| 1888........do.... | 307,386 | 95,290 | 1901.........do.... | 552,043 | 154,572 |
| 1889........do.... | 418,891 | 125,667 | 1902.........do.... | 513,893 | 128,472 |
| 1890........do.... | 387,847 | 104,719 | 1903.........do.... | 598,500 | 167,580 |
| 1891........do.... | 343,000 | 54,880 | 1904.........do.... | 897,100 | 269,130 |
| 1892........do.... | 379,480 | 64,502 | 1905.........do.... | 1,192,758 | 178,914 |
| 1893........do.... | 348,399 | 104,520 | 1906.........do.... | 1,283,250 | 165,204 |
| 1894........do.... | 379,444 | 102,450 | 1907.........do.... | 1,379,496 | 195,281 |

In 1907 these States produced 1,379,496 pounds of bromine, valued at $195,281, the average price per pound being a little more than 14 cents. The conditions in the trade were therefore somewhat better than in 1906; for in that year, though there was an increased production of 90,492 pounds, there was a decrease in value of $13,710, and prices fell to an average of 12.8 cents per pound. The value per pound in 1907 is still below that for 1905, namely 15 cents. Prices were extremely low in 1907, and in some cases barely equal to the cost of production. The low prices are in large part, if not wholly, due to the heavy importation of German bromides.

Michigan furnished the greater part of the output of bromine in 1907. According to F. J. H. Merrill,[a] the brines in that State containing bromine in commercial quantities come from the Marshall sandstone, in the "Upper" Carboniferous, and contain from 0.1 to 0.3 per cent of bromine. At Midland and Mount Pleasant, where large quantities of bromine and bromide are made, special processes controlled by patents are in use. The bromine is freed from its usual combination with alkaline bases by means of the electric current. The free bromine is then blown out of the solution by air and absorbed by caustic soda.

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[a] Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906 pp. 1097–1098.

Bromine was made as a by-product in 1907 at Pomeroy, Meigs County, Ohio, and at Hartford, Mason County, W. Va., towns about 5 miles apart on the Ohio River, along one of its sharp bends.

The practice in Ohio by which bromine is obtained from brine has been described by Bownocker,[a] and the fundamental chemical principles involved are, so far as known, those usually involved in the manufacture of bromine in the United States. Bownocker's description is as follows:

> After the salt has been removed from the grainers the remaining liquid, known as bittern and having a density of from 35° to 40° B., is run into a tank, where it settles. It is then conducted to a still, the body of which is made of sandstone.
>
> The bittern and chemicals are poured into the still through a funnel-shaped opening in the top, and withdrawn from the still by a small opening in the bottom, after the bromine has been removed. Steam is blown into the still by a small opening in the bottom, producing a temperature reported at about 180° F.
>
> The condenser is simply a rectangular box about 5 feet long, through which pass three lead pipes extending from the still at one end to the bottle which collects the bromine at the other. Cold water is kept running through the box, condensing the bromine.
>
> The bromine exists in the bittern as magnesium bromide ($MgBr_2$), comprising about one-half of 1 per cent of the mass.[b] After bittern has been run into the still and steam turned in, sulphuric acid ($H_2SO_4$) is added, the proportion being 1 pound of the latter to 20 gallons of the former. This is followed by the addition of potassium chlorate ($KClO_3$), the ratio being 1 pound to 60 gallons of bittern.
>
> The following reaction takes place in the still:
>
> $$3MgBr_2 + KClO_3 + 3H_2SO_4 = 6Br + KCl + 3MgSO_4 + 3H_2O.$$
>
> The bromine escapes as a gas, but is changed to a liquid in the condenser.
>
> Formerly manganese dioxide ($MnO_2$) was used in place of the potassium chlorate, the change resulting from the lower cost of the latter.

At Malden, on the Kanawha River, a few miles southeast of Charleston, W. Va., the brine that is used in the manufacture of bromine is obtained from the Pottsville formation, and at Pittsburg it comes from the Pocono.

Bromine is used mostly in the form of alkaline bromides in medicine and photography. In its elementary form it is also used in the manufacture of certain dyes, as a disinfectant, and in certain metallurgical operations.

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# SULPHUR AND PYRITE.

By W. C. Phalen.

## SULPHUR.

### PRODUCTION.

In 1907 sulphur was produced in the United States in Louisiana, Nevada, Wyoming, Utah, and Colorado. The output of each of these States, except Louisiana, was small. The importance of the sulphur industry in America has grown rapidly within the last few years, and the phenomenal production of 294,153 long tons in 1906 was nearly equaled by the production of 293,106 long tons in 1907. A decrease in production was reported from Utah, Nevada, and Wyoming. Louisiana reported an increased production in 1907 as compared with that of 1906, and Colorado, which did not produce any sulphur in 1906, was added to the list of producing States. The value of most of the output during 1907 has been compiled from current market prices in New York, which ranged from $22.125 per long ton during the first nine months of the year to from $19 to $19.50 per ton at its close. From the New York prices the value at the mine has been computed. The total value of $5,142,850 obtained in this manner is an advance over the value for 1906 of $46,172.

The production of the country since 1880 is shown in the following table:

*Production of sulphur in the United States, 1880–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1880..long tons.. | 536 | $21,000 | 1894..long tons.. | 446 | $20,000 |
| 1881......do.... | 536 | 21,000 | 1895......do.... | 1,607 | 42,000 |
| 1882......do.... | 536 | 21,000 | 1896......do.... | 4,696 | 87,200 |
| 1883......do.... | 893 | 27,000 | 1897......do.... | 2,031 | 45,590 |
| 1884......do.... | 446 | 12,000 | 1898......do.... | 1,071 | 32,960 |
| 1885......do.... | 638 | 17,875 | 1899......do.... | 4,313 | 107,500 |
| 1886......do.... | 2,232 | 75,000 | 1900......do.... | 3,147 | 88,100 |
| 1887......do.... | 2,679 | 100,000 | 1901......do.... | [a] 241,691 | 1,257,879 |
| 1888......do.... | ........ | ........ | 1902......do.... | [a] 207,874 | 947,089 |
| 1889......do.... | 402 | 7,850 | 1903......do.... | [a] 233,127 | 1,109,818 |
| 1890......do.... | ........ | ........ | 1904......do.... | 127,292 | 2,663,760 |
| 1891......do.... | 1,071 | 39,600 | 1905......do.... | 181,677 | 3,706,560 |
| 1892......do.... | 2,400 | 80,640 | 1906......do.... | 294,153 | 5,096,678 |
| 1893......do.... | 1,071 | 42,000 | 1907......do.... | 293,106 | 5,142,850 |

[a] Includes the production of pyrite.

## OCCURRENCE.

*Louisiana.*—The deposits of sulphur in Calcasieu Parish, La., have been referred to the Cretaceous series by Harris and Veatch.[a]

About 1868 the Louisiana Oil Company was formed to exploit the oil and gas springs at the head of Bayou Choupique, about 15 miles west of Lake Charles. At a depth of 443 feet a deposit of sulphur was encountered. A year or two later other borings proved the sulphur-bearing bed to be about 100 feet thick. The beds of water-bearing sand overlying the sulphur bed made the sinking of a shaft practically impossible. Later on the company succeeded in forcing a large-sectioned cast-iron shaft to a depth of 110 feet, when it was abandoned on account of the breaking of the lining. After these attempts little was done at the sulphur deposits until 1895, when the invention of the "Frasch process" by Mr. Herman Frasch, of Cleveland, Ohio, caused a resumption of active work.

The Frasch process of obtaining sulphur has been described in many places, and an improved method was detailed by Mr. Frasch recently.[b] Briefly, the process is as follows:[c] A well is driven through the various strata to the sulphur-impregnated beds in much the same manner as is usual in sinking wells for oil and gas. In each well there are placed concentrically four lines of pipe, having diameters ranging from 10 inches to 1 inch. Superheated water and hot air is forced down the pipes and the spaces between them to melt the sulphur and to bring it to the surface. The hot water flows down between the two outer pipes which are respectively 10 inches and 6 inches in diameter, and passes into the limestone, melting the sulphur. The quantity of sulphur melted and the range of action of the water depend on the temperature of the water and on the pressure at which it is supplied. The heavy melted sulphur runs back into the sump around the well pipe, which it enters through holes provided for this purpose. Hot compressed air is forced down through the smallest or 1-inch pipe and at the bottom of the well mixes with the melted sulphur and forms an aerated mass sufficiently low in specific gravity to allow the water pressure to elevate the melted sulphur to the surface, where it is discharged into large rectangular vats, constructed of rough planking. The dimensions of the vats vary somewhat, but they are made as large as 350 by 250 by 40 feet, and some of them are so arranged that railroad trains can pass between them. The vats are filled as an ordinary water tank would be, but the viscosity of the sulphur as it cools prevents the formation of perfectly horizontal layers, and the flow of sulphur is being constantly deflected to different parts of the vat. In this manner cooling, solidification, and feeding go on simultaneously. The hardened sulphur is broken up by workmen either by pick, crowbar and shovel, or by blasting. The sulphur going to the Atlantic seaboard is first shipped by rail to Sabine Pass on the Gulf coast, where it is loaded into ships by machinery; the remainder is shipped by rail to various other points in the country. At the close of the year 1907 thirty wells were reported in operation.

*Wyoming.*—The hot sulphur springs and travertine deposits near Cody, Wyo., have been described by numerous observers, and the latest account is by Mr. E. G. Woodruff,[a] of the United States Geological Survey. The deposits are located about 3 miles west of Cody, along the base of Cedar Mountain, on the south side of Shoshone River, in secs. 3 and 10, T. 52 N., R. 102 W. The deposits considered workable occur in a narrow belt 2 miles long, extending from Hot Springs southeast to Sulphur Creek.

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[a] Rept. Geol. Survey Louisiana for 1899, p. 62.

[b] The Mining World, December 14, 1907.

[c] Willey, D. A., Eng. and Min. Jour., December 14, 1907

The sulphur occurs native in small yellow crystals and as gray streaks in the rock. Where mining operations are in progress it is found in irregular beds in limestone and travertine, associated with fine, white, crystalline aggregates of gypsum, filling cavities 2 to 8 inches in diameter and also disseminated through the limestone. The cavities are thought to be portions of subterranean channels through which the hot sulphur-bearing waters flowed, and on the walls of which the sulphur was gradually deposited until the chamber was partly or entirely filled. In the areas between the groups of cavities only small quantities of sulphur are found, but in the enriched pockets sulphur constitutes from 30 to 50 per cent of the rock. Laterally, a deposit may be rich at one point and barren 10 feet away. The depth of mineralization is not known, as mining and prospecting have been carried only to a depth of 20 feet, but it seems improbable that rich pockets of sulphur will be found far below the surface.

The evidence seems clear that the sulphur was deposited by hot springs, the heat coming from slowly cooling magmatic intrusions, increased probably to a slight extent by the heat from chemical reactions. As the waters bearing the sulphur compounds approach the surface, sulphur is deposited, due to cooling and oxidation. As both these processes take place in a comparatively restricted superficial zone, it follows that the richer deposits will probably be found near the surface, and they may tend to diminish in depth. The fact that the deposits are associated with calcareous material is of significance, indicating that the limestone may be essential to the deposition of the sulphur—the more so as it is known that the hot waters have passed through siliceous rocks.

Mining is carried on in open pits, and the rock is blasted out with powder. It is sorted by hand, and all ore over 30 per cent is hauled to the smelter of the Bighorn Sulphur Company near the mouth of Shoshone Canyon. The average sulphur content of the ore smelted is 35 per cent. At the smelter the ore is run from storage bins into small steel cars of 1¼ tons capacity, and a train of 3 cars is then run into cylindrical retorts and the sulphur melted by steam. The molten sulphur flows through the perforated sides of the cars, thence to the bottom of the retort, from which it flows through a trap into bins where it cools. After cooling, the sulphur is ground in an 8-inch Blake crusher and pulverized to a fine powder in a rotary grinder. Only two-thirds of the sulphur in the rock is obtained. A large part of the product is shipped to Omaha, Nebr., and the remainder is used in the manufacture of sheep-dipping preparations in Wyoming and adjacent States.

*Utah.*[b]—The Utah sulphur deposits that were worked during 1907 are located near Black Rock, Beaver County. The sulphur is found in beds of soft, rhyolitic tuff, which some of the miners call "gypsum." The series in which the tuffs are found are thought to overlie Paleozoic sediments. The sulphur beds are located in or near a zone of intense faulting and volcanic activity which is not yet ended, and hydrogen sulphide ($H_2S$) is still escaping from the line of sulphur beds.

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[a] Bull. U. S. Geol. Survey No. 340-L, 1908.

[b] Lee, W. T., The Cove Creek sulphur beds, Utah: Bull. U. S. Geol. Survey 315, 1907 pp. 485-489.

The sulphur occurs mainly as a dark-colored impregnation or cement in the rhyolitic tuff, but it is also found in cylindrical masses 10 to 15 feet in diameter, having a rude radial structure, and as irregular veins of pure yellow sulphur often several inches thick. The sulphur ore varies greatly in richness, from material containing only a trace to ore nearly 100 per cent pure. Material having as little as 15 per cent sulphur is considered paying ore.

The cost of production is considerably more than would be the case were operations conducted on a scale justifying the installation of labor-saving machinery. Surface stripping by horses and scrapers to a depth of 10 feet is practiced, and the ore is removed by manual labor and taken to the smelter. Here it is placed in iron retorts and melted by steam forced into it at a pressure of 60 pounds and at a temperature of 144° C. The liquid sulphur is drawn off through the bottom into iron receptacles and cooled in masses weighing 200 pounds. In this form it is stored until needed, when it is ground and shipped in sacks.

*Philippine Islands.*[a]—Several small sulphur deposits, of which the most noted are known as the San Antonio and the Santa Rosalie deposits, are located on the slopes of Mount Guiron, on the Island of Biliran, Philippine Islands. Sulphur from these deposits would have to compete with Japanese sulphur, the price of which at Manila is 50 pesos per ton. With present transportation facilities it is calculated that the cost of delivering refined sulphur at Manila from the San Antonio deposits would be about 37 pesos per ton, and that sulphur from other sources could not compete with the Japanese product, owing to higher cost of production and delivery.

## IMPORTS AND EXPORTS.

For the first time in the history of the importation of sulphur into the United States the total value of the imports amounted to less than $1,000,000. The great decline in 1907, as was to be expected, was in the quantity and value of the crude sulphur received into the country, the falling off in quantity of this sulphur amounting to 72 per cent. The total value of the imports into the United States in 1907 was but 32 per cent of what it was in the preceding year. The production of Louisiana sulphur has reached a point where it is able to supply the domestic requirements. In the following table the total importation for consumption is given for the last six years:

*Sulphur imported and entered for consumption in the United States, 1903 to 1907, in long tons.*

| Year. | Crude. | | Flowers of sulphur. | | Refined. | | All other.[b] | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| 1902 | 170,601 | $3,334,002 | 738 | $19,954 | 14 | $369 | 27 | $3,325 | $3,357,650 |
| 1903 | 188,900 | 3,649,756 | 1,854 | 52,680 | 160 | 3,746 | 29 | 3,508 | 3,709,690 |
| 1904 | 127,966 | 2,462,360 | 1,332 | 39,133 | 163 | 4,373 | 41 | 5,403 | 2,511,269 |
| 1905 | 82,961 | 1,528,136 | 572 | 16,037 | 779 | 19,960 | 27 | 3,352 | 1,567,485 |
| 1906 | 72,404 | 1,282,873 | 1,100 | 20,565 | 709 | 17,918 | 28 | 3,224 | 1,333,580 |
| 1907 | 20,399 | 355,944 | 1,458 | 41,216 | 606 | 14,589 | 60 | 8,426 | 420,175 |

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[a] Eng. and Min. Jour., December 7, 1907.

[b] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

In the following table are given the statistics of imports by countries from which sulphur was exported into the United States, and by ports at which it was received, for the years 1905 to 1907, inclusive. The falling off in the importations from Italy and the marked diminution in the quantity of the imports as a whole are the most noteworthy features.

*Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each calendar year, 1905 to 1907, in long tons.*

| Countries whence exported and customs districts through which imported. | 1905. |  | 1906. |  | 1907. |  |
|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRY. |  |  |  |  |  |  |
| Canada | 18 | $472 | ........ | ........ | ........ | ........ |
| United Kingdom | 1,656 | 35,733 | 3,881 | $76,068 | 226 | $4,654 |
| Italy | 69,135 | 1,274,014 | 47,629 | 868,453 | 3,393 | 60,152 |
| Japan | 12,307 | 210,191 | 20,848 | 337,323 | 16,699 | 292,361 |
| Other countries | 85 | 1,595 | 46 | 1,029 | ........ | ........ |
| Total | 83,201 | 1,522,005 | 72,404 | 1,282,873 | 20,318 | 357,167 |
| CUSTOMS DISTRICT. |  |  |  |  |  |  |
| Baltimore, Md | ........ | ........ | ........ | ........ | 13 | 328 |
| Boston and Charlestown, Mass | 8,585 | 171,235 | 7,552 | 150,244 | 200 | 4,136 |
| New Orleans, La | ........ | ........ | 185 | 4,437 | ........ | ........ |
| New York, N. Y | 44,062 | 805,041 | 35,798 | 631,959 | 3,141 | 54,231 |
| Philadelphia, Pa | 3,063 | 47,948 | 5,892 | 86,824 | ........ | ........ |
| Portland, Me | 15,150 | 286,378 | 7,050 | 139,581 | ........ | ........ |
| San Francisco, Cal | 9,145 | 131,795 | 12,192 | 198,010 | 11,224 | 192,906 |
| Willamette, Oreg | 2,994 | 75,558 | 3,530 | 67,362 | 3,827 | 70,572 |
| All other | 202 | 4,050 | 205 | 4,456 | 1,913 | 34,994 |
| Total | 83,201 | 1,522,005 | 72,404 | 1,282,873 | 20,318 | 357,167 |

In 1906 the United States exported 22,237 long tons of sulphur, valued at $460,435; in 1907 the exports increased to 35,925 long tons, valued at $734,749. Most of this sulphur was exported to France. As the total imports were only 22,523 long tons, it is apparent that the domestic production exceeded the consumption by 13,402 tons. A few years ago this would have been considered beyond any possibility.

## FOREIGN SOURCES OF SULPHUR.

*Sicily.*—For ten years prior to August, 1906, more than three-quarters of the sulphur industry of Sicily had been in the hands of the Sicilian Sulphur Company (Limited), of London, which virtually controlled the sulphur business of the world during that period. When the contract between the English company and the Sicilian sulphur producers came to an end on August 1, 1906, the former had a large stock of sulphur (estimated at 450,000 tons) on hand. To avoid a reduction in the price of sulphur, which would doubtless have involved disastrous results to the industry in Sicily, the Italian Parliament passed a law requiring all Sicilian sulphur to be sold through the "Consorzio Obligatorio," presided over by a royal commissioner, with Government resources behind it. At a conference between representatives of the Sicilian and the American sulphur interests held in July, 1907, the Italians insisted that American sulphur should be kept out of the European market. The American interests declined to entertain such a proposition, and in August, 1907, the situation in Sicily became decidedly threatening as a result of the Italian Government's attempt to reduce wages. About the same time it was decided to throw upon the American market the stock of sulphur accumulated in Sicily. With this end in view a first cargo of 3,000 tons was sent over, and it was understood that more was to follow. In October, 1907, prices on prime Louisiana sulphur to New York, Boston, and Portland were quoted at from $19 to $19.50 per long ton, a drop from $22.125, the price which had obtained during the early part of the year. Early in January of the present year, 1908, the Consorzio and the American producers came to an understanding and prices were again advanced to $22 per ton and have remained at this figure up to the time of writing (June, 1908).

In spite of the fact that quotations have been more than $22 per ton the greater part of the year, it is significant that the exportation of Sicilian sulphur to the United States has shown a constant and marked decline. Four years ago the importation of Sicilian sulphur amounted to more than 100,000 long tons. With the growth of the Louisiana sulphur industry, Sicilian sulphur in the United States has become almost a negligible quantity, as will be seen from the importation from Sicily of but 3,393 long tons in 1907. The following table, reported by Messrs. Emil Fog and Sons,[a] of Messina, of exports of sulphur from Sicily, by countries, during the past four years, indicates the falling off in the exports to the United States. This statement shows that 9,476 long tons were shipped from Sicily in 1907, but only 3,393 tons reached the United States during that year. Of the 9,476 tons shipped to this country in 1907, 8,598 tons were best unmixed seconds and 878 tons were refined sulphur.

*Total exports of sulphur from Sicily, 1904–1907, by countries, in long tons.*

| Country. | 1904. | 1905. | 1906. | 1907. |
|---|---|---|---|---|
| Austria | 23,374 | 25,111 | 22,756 | 24,597 |
| Belgium | 13,627 | 14,442 | 13,940 | 8,853 |
| France | 103,042 | 96,170 | 67,536 | 59,725 |
| Germany | 31,613 | 28,319 | 34,967 | 37,100 |
| Greece and Turkey | 25,376 | 25,069 | 26,560 | 27,608 |
| Holland | 8,122 | 4,425 | 5,539 | 11,379 |
| Italy | 79,619 | 99,633 | 79,519 | 58,926 |
| Portugal | 8,373 | 13,196 | 12,302 | .......... |
| Russia | 15,141 | 16,673 | 16,181 | 15,210 |
| Scandinavia | 20,120 | 18,288 | 21,608 | 25,155 |
| Spain | 4,063 | 2,478 | 3,120 | [a] 12,778 |
| United Kingdom | 18,108 | 18,847 | 20,883 | 16,561 |
| United States | 100,680 | 70,332 | 41,283 | 9,476 |
| Other countries | 24,487 | 23,277 | 21,238 | 26,646 |
| Total | 475,745 | 456,260 | 387,432 | 334,014 |

[a] Includes Portugal.

The following table, obtained from information furnished by the official report Revista del Servizio Minerario, gives the quantity and value of sulphur produced in Italy from 1901 to 1906, inclusive:

*Production of sulphur in Italy, 1901–1906.*

| | | | |
|---|---|---|---|
| 1901 | long tons | 554,096 | $10,358,496 |
| 1902 | do | 530,938 | 10,068,811 |
| 1903 | do | 545,030 | 10,278,193 |
| 1904 | long tons | 519,255 | $9,740,776 |
| 1905 | do | 559,967 | 10,269,363 |
| 1906 | do | 491,942 | 8,882,163 |

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[a] Eng. and Min. Jour., February 29, 1908; also Mining World, February 29, 1908.

One of the most unfavorable features of the Sicilian sulphur situation is the heavy accumulation of the stocks of sulphur at various ports. At the close of the year 1907, 576,377 tons of sulphur, or about two years' exports, were on hand, an increase since 1902 of about 70 per cent.[a]

To carry this immense stock of sulphur requires a large outlay of capital, which, fortunately for the Sicilian industry, has been guaranteed by the Italian Government. The stocks of sulphur on hand during the years from 1902 to 1907, inclusive, are shown in the following table:

*Stocks of sulphur on hand in Sicily, 1902-1907, in long tons.*

| | | | |
|---|---|---|---|
| 1902 | 339,113 | 1905 | 462,437 |
| 1903 | 361,220 | 1906 | 525,115 |
| 1904 | 396,541 | 1907 | [b] 576,377 |

*Mexico.*—An old sulphur deposit near Conejos, Durango, Mexico, has recently been described by Douglas Muir.[c] The sulphur occurs native in both crystalline and massive form, associated with gypsum. Ore carrying less than 15 per cent is not considered commercial. The refined product is 99 per cent pure, and the residue from the smelting process carries from 3 to 5 per cent sulphur. All the output is consumed by the local market.

*Baluchistan.*[d]—The Geological Survey of Baluchistan has recently examined the old sulphur mines of Sanni. These mines have not been worked for many years, and are now in an almost inaccessible condition. It is reported that the quantity of sulphur impregnating the associated sandstones and clays is quite sufficient to hold out prospects of remunerative working, especially when the favorable situation of the mines is considered. The rock in the neighborhood of the sulphur mines is impregnated with alunite.

## WORLD'S PRODUCTION OF SULPHUR.

The following table shows the estimated quantity of sulphur produced by all countries for the years 1905 and 1906:

*World's production of sulphur, 1905-1906, in metric tons.*

| Country. | 1905. | | 1906. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| **United States** | 184,584 | $3,706,560 | 298,859 | $5,096,678 |
| **Austria** | 1,700 | 32,292 | [e] 1,579 | [e] 30,000 |
| **Chile** | 3,510 | 123,647 | [e] 4,000 | [e] 125,000 |
| **France** | 740 | 14,057 | [e] 789 | [e] 15,000 |
| **Greece** | 1,126 | 23,353 | [e] 1,200 | [e] 24,000 |
| **Hungary** | 135 | 4,000 | [e] 140 | [e] 4,200 |
| **Italy** | 568,927 | 10,269,363 | 499,814 | 8,882,163 |
| **Japan** | 24,419 | 259,650 | 28,332 | [e] 306,083 |
| **Spain** | 2,285 | 43,421 | [e] 2,263 | [e] 43,000 |
| **Total** | 787,426 | 14,476,403 | 836,976 | 14,526,124 |

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[a] Mining World, February 29, 1908; and Paint, Oil, and Drug Review, March 11, 1908.
[b] Mining World, February 29, 1908.
[c] Mining Science, February 27, 1908, p. 225.
[d] Min. and Sci. Press, October 26, 1907.
[e] Estimated.

## PYRITE.

### PRODUCTION BY STATES.

The production of pyrite in the United States in 1907 amounted to 247,387 long tons, valued at $794,949. This was a decrease in both quantity and value as compared with the returns for 1906. Some of the States which usually produce the larger quantities of pyrite reported a falling off in output. The New York production, which in the table is combined with that of Massachusetts, represents concentrated or refined material the average value of which per ton was about $4.25. To the tonnage of the refined material in New York there was added less than 1,000 tons of material which was sold in the crude form. The quantity of such crude material was so small as compared with the total production that the addition involved a reduction in the average price per ton in that State of only 13 cents. The pyrite produced throughout the country is mostly consumed in the manufacture of sulphuric acid.

In the following table is given the production of pyrite in the United States by States during the last three years:

*Production of pyrite in the United States, 1905–1907, by States, in long tons.*

| State. | 1905. | | | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. |
| Alabama and Georgia | 19,928 | $71,863 | $3.61 | 26,173 | $78,817 | $3.01 | 28,281 | $85,307 | $3.02 |
| California | 61,748 | 247,712 | 4.01 | 52,926 | 236,867 | 4.48 | 51,950 | 174,549 | 3.36 |
| Indiana | 3,107 | 11,491 | 3.70 | 2,579 | 7,179 | 2.78 | [a] 4,929 | 14,713 | 2.98 |
| Massachusetts and New Jersey | [b] 24,155 | 108,765 | 4.50 | (c) | (c) | ...... | (c) | (c) | ...... |
| New York | 11,935 | 39,883 | 3.34 | [d] 46,218 | [d] 162,615 | 3.52 | [d] 30,671 | 126,991 | 4.14 |
| Ohio | 8,944 | 32,770 | 3.66 | 4,732 | 14,439 | 3.05 | 6,816 | 20,803 | 3.05 |
| Virginia | 123,183 | 426,008 | 3.46 | 128,794 | 431,388 | 3.35 | 124,740 | 372,586 | 2.99 |
| Total | 253,000 | 938,492 | 3.71 | 261,422 | 931,305 | 3.56 | 247,387 | 794,949 | 3.21 |

[a] Includes the production of Illinois.
[b] Includes the production of South Dakota.
[c] Included in New York.
[d] Includes the production of Massachusetts.

*Alabama.*—The production of pyrite in Alabama in 1907 was less than in 1906. The output was mined chiefly by the Alabama Southern Ore and Copper Company and by the Southern Sulphur Ore Company. The former company was organized in April, 1907, and absorbed the Alabama Pyrites Company. The shipping mines are confined to the vicinity of Pyriton, Clay County, and a branch of the Louisville and Nashville Railroad affords transportation facilities from Stockdale. Some of the pyrite contains copper, which appears to increase with depth and which, of course, adds to the value of the ore.

*California.*—There was a decrease in the output of pyrite from California in 1907 as compared with 1906. Most of the pyrite is manufactured directly into sulphuric acid or else sold for its sulphur content. Some of the pyrite used carries copper.

*Georgia.*—There was a decided increase in the production of pyrite in Georgia in 1907. This accounts for the increase in the production of Georgia and Alabama as tabulated above. Georgia pyrite is mined near Acworth, Cobb County, and at Villa Rica, about 30 miles west of Atlanta.

*Indiana and Illinois.*—There was an increase in the production of pyrite in 1907 in Indiana. Illinois also reported a small output. The production of these two States is in the form of pyrite nodules cobbed from coal. Part of the material is sold to manufacturers of fertilizers, who manufacture from it sulphuric acid used in the preparation of superphosphate.

*New York.*—The commercial production of pyrite in 1907 was confined to St. Lawrence County, where mining has been carried on more or less intermittently for several years. The pyrite is associated with crystalline limestone and schists and occurs in bedded veins, impregnated zones, or fahlbands, which in places widen into lenses or shoots similar to those encountered in the Adirondack magnetite deposits of New York. The pyrite is associated with a quartz and feldspar gangue. The zones strike northeast and are conformable to the wall rock. The more important zones are found in a line extending from near Gouverneur, where the American Pyrites Company operated during 1907, northeast to the High Falls mine, in the town of Canton. Pyrrhotite occurs in considerable quantity at the High Falls mine.

During 1907 the Oliver Iron Mining Company acquired an option from the National Pyrites Company of the High Falls mine. No shipments were made in 1907, but considerable exploratory work was done. Three or four carloads of concentrates were shipped early in 1908.

An account of the mining and milling practice connected with the pyrite industry in New York has been published by Mr. R. D. Brinsmade.[a] According to this writer, the future of the pyrite industry in New York depends chiefly upon commercial considerations. The sulphite pulp industry in the Adirondacks consumes large quantities of sulphurous acid and should afford an excellent market for the output of pyrite from St. Lawrence County. This pyrite contains no deleterious impurities to prevent its use in making sulphuric acid, and the quantity available is large.

*Ohio.*—There was a decided increase in the production of pyrite in Ohio in 1907. The pyrite is obtained in preparing coal for market.

*Virginia.*—Virginia led in the production of pyrite in 1907, with an output of 124,740 long tons, valued at $372,586. The trade continued good the greater part of the year. Virginia pyrite comes from three different localities, namely, Mineral, Louisa County; Dumfries, Prince William County, and Pulaski, Pulaski County. The pyrite deposits of Louisa and Prince William counties consist of a series of lens-shaped bodies nearly conformable with the inclosing slates and schists. The lenses vary in size; as a rule those occurring at Mineral are thicker than those found elsewhere. The lenses are developed by inclined shafts, but the details of mining as practiced in Louisa County differ from those employed at Dumfries owing to the different conditions encountered. A description of the usual practice in mining and milling Virginia pyrite, as well as a statement of the cost attached thereto, has been given by R. K. Painter.[b]

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[a] Eng. and Min. Jour., October 28, 1905; Mineral Industry, vol. 14, 1905, pp. 525–527.

[b] Mineral Industry, vol. 14, 1905, pp. 522–525.

The following table shows the development of the pyrite industry in the United States since 1882:

*Production of pyrite in the United States, 1882–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1882..long tons.. | 12,000 | $72,000 | 1895..long tons.. | 99,549 | $322,845 |
| 1883......do.... | 25,000 | 137,500 | 1896......do.... | 115,483 | 320,163 |
| 1884......do.... | 35,000 | 175,000 | 1897......do.... | 143,201 | 391,541 |
| 1885......do.... | 49,000 | 220,500 | 1898......do.... | 193,364 | 593,801 |
| 1886......do.... | 55,000 | 220,000 | 1899......do.... | 174,734 | 543,249 |
| 1887......do.... | 52,000 | 210,000 | 1900......do.... | 204,615 | 749,991 |
| 1888......do.... | 54,331 | 167,658 | 1901......do.... | [a] 241,691 | 1,257,879 |
| 1889......do.... | 93,705 | 202,119 | 1902......do.... | [a] 207,874 | 947,089 |
| 1890......do.... | 99,854 | 273,745 | 1903......do.... | [a] 233,127 | 1,109,818 |
| 1891......do.... | 106,536 | 338,880 | 1904......do.... | 207,081 | 814,808 |
| 1892......do.... | 109,788 | 305,191 | 1905......do.... | 253,000 | 938,492 |
| 1893......do.... | 75,777 | 256,552 | 1906......do.... | 261,422 | 931,305 |
| 1894......do.... | 105,940 | 363,134 | 1907......do.... | 247,387 | 794,949 |

## IMPORTS.

In view of the large and constantly growing importation of pyrite into the United States, the development of the deposits which are known should be stimulated. The importation of pyrite still greatly exceeds the domestic supply, and the value of the imported material is more than three times that of the domestic production. Foreign pyrite comes chiefly from Spain, Portugal, Canada, and Newfoundland.

*Imports of pyrite containing not more than 3.5 per cent of copper, 1902–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1902..long tons.. | 440,363 | $1,650,852 | 1905..long tons.. | 511,946 | $1,774,379 |
| 1903......do.... | 420,410 | 1,636,450 | 1906......do.... | 598,078 | 2,148,558 |
| 1904......do.... | 422,720 | 1,533,997 | 1907......do.... | 627,985 | 2,581,787 |

## WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite, together with the quantity of pure sulphur which it is supposed to replace in the market. The latter figure is calculated on the assumption that the pyrite averages 45 per cent sulphur.

*World's production of iron pyrite and quantity of sulphur displaced, 1902–1906, in long tons.*

| Country. | 1902. | 1903. | 1904. | 1905. | 1906. |
|---|---|---|---|---|---|
| Spain | 142,708 | 153,543 | 159,292 | 176,258 | 186,262 |
| France[b] | 313,204 | [b] 324,212 | 267,268 | 262,907 | 261,084 |
| Portugal | 407,173 | 370,253 | 377,540 | 346,928 | 345,222 |
| United States | 207,874 | 233,137 | 207,081 | 253,000 | 361,422 |
| Germany | 162,613 | 168,307 | 172,030 | 182,448 | 193,860 |
| Norway | 101,016 | 127,887 | 131,499 | 159,461 | 194,770 |
| Hungary | 104,806 | 95,560 | 95,618 | 105,165 | 110,849 |
| Italy | 91,704 | 99,857 | 110,240 | 115,814 | 120,437 |
| Canada | 31,800 | 33,039 | 29,490 | 20,236 | 35,365 |
| Newfoundland | 26,000 | 42,000 | 60,200 | 50,720 | 28,132 |
| Russia | 26,048 | 22,420 | (c) | (c) | (c) |
| United Kingdom | 9,168 | 9,639 | 10,287 | 12,180 | 11,140 |
| Bosnia and Herzegovina | 5,068 | 6,484 | 10,256 | 18,745 | 13,262 |
| Belgium | 699 | 709 | 1,058 | 961 | 804 |
| Sweden | (c) | 7,670 | 15,705 | 20,435 | 21,483 |
| Total | 1,629,901 | 1,694,717 | 1,693,492 | 1,742,686 | 1,884,191 |
| Sulphur displaced[d] | 733,455 | 762,623 | 762,071 | 784,209 | 847,886 |

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[a] Includes production of natural sulphur.

[b] Includes Algeria.

[c] Statistics not available.

[d] Based on estimated 45 per cent of sulphur content.

## CONSUMPTION OF SULPHUR IN THE UNITED STATES.

The consumption of sulphur in the United States is taken as the sum of the domestic production and the quantity imported together with the sulphur content of the domestic and imported pyrite. The figures for the sulphur consumed in the United States during the last three years are given below:

*Consumption of sulphur in the United States, 1905–1907, in long tons.*

| Source. | 1905. | 1906. | 1907. |
|---|---|---|---|
| Domestic sulphur and sulphur content of pyrite | 295,527 | 411,793 | 404,430 |
| Imported sulphur | 84,339 | 74,441 | 22,523 |
| Sulphur content of imported pyrite[a] | 230,376 | 269,135 | 282,593 |
| Total domestic consumption | 610,242 | 755,369 | 709,546 |

[a] Based on average sulphur content of 45 per cent.

# BARYTES AND STRONTIUM.

By Ernest F. Burchard.

## BARYTES.

### CHARACTER.

Barytes or heavy spar is barium sulphate, the chemical formula of which is $BaSO_4$. The mineral is composed of barium monoxide (baryta, BaO), 65.7 per cent, and sulphur trioxide ($SO_3$), 34.3 per cent. The specific gravity is 4.3 to 4.6; the hardness, 2.5 to 3.5. Barytes is usually a white, opaque to translucent crystalline material, about as hard as calcite, but differing from the latter by its greater specific gravity and the fact that it does not effervesce with acids. It is frequently found stained reddish, pink, or yellow by iron oxide. A common form of the mineral is that of an aggregate of straight or slightly curved cleavable plates. It also occurs in granular, fibrous, and earthy masses, and in stalactitic forms, as well as in single and clustered crystals. In nature the material is rarely pure, the most common impurities being silica, lime, magnesia, and the oxides of iron and aluminum. Fine particles of galena are disseminated through some deposits of barytes; for instance, in Washington County, Mo. Commercial grades as mined carry 95 to 98 per cent barium sulphate and 1 to 3 per cent silica.

### DISTRIBUTION.

Barytes occurs commonly in veins as a gangue of metallic ores, and also in veins in sandstone and limestone, or as a replacement of limestone. Differential weathering of the limestone and barytes has given rise to deposits of barytes embedded in residual clay. It thus may have a wide range in geologic age and an extensive distribution. The principal sources, however, are limited to two districts—that of Missouri and the Appalachians. In Missouri the counties of Washington, St. Francois, Crawford, Cole, Miller, and Morgan are producers, Washington County furnishing three-fourths of the output of the State. The Appalachian district includes portions of Virginia, Tennessee, and North Carolina. There is also a newly developed area in central Kentucky. Considerable barytes has been found also in the Cumberland Valley in southern Pennsylvania, although little has been produced there.

## USES AND REQUIREMENTS.

One of the principal uses of barytes is as a white pigment on account of its weight, absence of color, and inertness, and, in order that the material may be suitable for such use, it must, after milling, be free from all associated minerals, such as clay, calcium carbonate, silica, iron oxide, manganese oxide, lead, and zinc ores. The fitness of barytes as a pigment is also due to its aptitude to take color stain uniformly, and to make a small quantity of color, such as aniline, cover much surface; and it is therefore used as a base for conveying many organic coloring matters that are used in paints. Other uses are in refining sugar; in enameling iron, oilcloths, and paper collars; in the manufacture of paper, cloth, rubber, lithophone, and barium salts (which have a wide chemical application), and as an adulterant.

## PREPARATION.

When dug from the residual clay in which they are usually embedded the barytes lumps are encrusted with clay, and are generally coated with iron oxide and stained deeply along every crack and seam. Masses of galena and chert likewise are often found adhering to the barytes. If the material is allowed to stand in the sun and rain, much of the clay becomes detached and drops off, and hand cobbing, picking, and sorting results in such further cleaning of the material that it is ready for shipment to the mills. This method of treatment is the one followed at the diggings in Missouri. The product from some workings in the southern Appalachian region is first washed in log washers to free it of associated clay. Next the barytes is separated into two or three grades by hand sorting, after which it is ready for the milling process.

Barytes can be milled by both the dry and the wet process. The wet process is the later and more effective one, and the one now most generally employed. Several types of mills are in use. The milling processes consist of crushing, grinding, washing, bleaching, and drying, although not necessarily in the order given. The most troublesome impurities seem to be galena and limonite. Where the galena occurs disseminated in fine grains through the barytes the two minerals are not easily separated by jigging or flotation. The limonite can not be entirely removed by ordinary jigging, and magnetic separation has been attempted but not yet accomplished. Bleaching, however, removes the iron if not present in quantity so great as to require an excessive quantity of sulphuric acid, but does not so readily affect the lead compound, which, when ground with the barytes, imparts a grayish tint to the material and thereby reduces its value as a pigment. Lime carbonate is also a deleterious impurity when it occurs in sufficient quantity to require a portion of the acid to neutralize it in the bleaching process.

One mill which prepares barytes to be shipped to other manufacturers who finish the product employs jaw crushers, geared rolls, and jigs, the material being treated with water from the beginning. At another type of mill the barytes is passed through a gyratory crusher, which breaks it into small lumps; then it goes to a log washer, next to lead-lined bleaching tanks, and then to a second log washer, from which it is elevated into a rotary, cylindrical drier heated by steam. The dried material is then pulverized in buhr mills arranged in two series of three each. The fine barytes emerging from the last mill is caught in barrels holding 550 to 600 pounds each.

An outline of the complete process in one of the most thoroughly equipped mills is, roughly, as follows: The crude material is ground in slip mills having granite grinders and granite bases. Water is fed into these mills and the ground material is floated over the top of the tanks, after which it is pumped into funnel-shaped separators. The contents of the separators are agitated by flowing water and the coarser, rejected material is drawn off at the bottom of the funnel and returns to the slip mills, while the finer material floats off at the top of the separators. This material next descends to settling tanks, and after forming a sludge is drawn off into bleaching tanks. The bleaching tanks are built of concrete lined with refractory tile. Bleaching is accomplished by the addition of measured weights of sulphuric acid to the sludge and the agitation of the mass to secure thorough mixture. The acid reacts on the iron oxide and lime present, forming ferrous sulphate and calcium sulphate. The iron salt being soluble and the calcium salt partially soluble, besides having a lower specific gravity than the pure barytes, these substances, together with the excess of sulphuric acid, are removable in the further washing process to which the material is subjected. For this next washing the material is pumped into washers which employ the float-separation process. Next, the bleached barytes passes to settling tanks, after which it is dried by being spread thinly on the surface of a rotating hot drum. From the hot drum the dried material falls or is brushed off and carried to Williams mills, where it is pulverized, screened, and finally sacked by machine. The essential difference between this process and the others mentioned above is in the fact that the material is first reduced to a fine condition before bleaching, thereby bringing the sulphuric acid intimately into contact with all portions of the barytes.

## TRADE CONDITIONS AND DEVELOPMENTS BY STATES.

The year 1907 began with a strong demand for finished barytes, occasioned by activity in the paint trade. This demand stimulated production and maintained high prices, at least during the first half of the year. With the general stagnation in business in the fall of 1907 the barytes industry suffered to a considerable extent, and at the close of the year many mines were idle with reserves of unsold barytes awaiting shipment, while several mills were closed and others were working with much reduced forces. Notwithstanding the depression attending the financial stringency, the prices for manufactured barytes remained high throughout most of the year with a slight drop in December.

*Alabama.*—The deposits near Ashville, which were producing in 1906, are reported to have been depleted and not to have produced any barytes in 1907.

*Georgia.*—Barytes occurs at several localities in the vicinity of Cartersville, Bartow County, Ga., and at one place, between 2½ and 3 miles southeast of Cartersville, mining of the mineral has been begun by the Nulsen, Klein & Krausse Manufacturing Company. A brief description of these deposits has been published recently by the Survey.[a]

Messrs. Hayes and Phalen describe in this paper the geologic relations of barytes and limonite deposits, both of which are associated with Beaver limestone and Weisner quartzite in such relations as to indicate that they appear originally to have replaced distinct beds in the shaly limestone overlying the quartzite. In their present condition the ores are residual, and it appears certain that gravity has aided in concentrating the barytes into workable deposits. The description concludes with the following paragraphs:

> The barite deposit, as shown in the present workings, has a thickness of about 50 feet normal to the slope of the surface. It is intermingled with residual material, chiefly red, brown, and yellow clay, with some fragments of quartzite. The barite itself makes up about one-third of the material removed in mining. It consists of irregular or slightly rounded bowlders ranging from a few ounces up to several hundred pounds in weight. It is for the most part of a massive, compactly granular structure, and of a pure white or faint bluish color. As it occurs in the face of the open pit its presence might not be suspected owing to films of ferruginous clay which cover the nodules. The iron stain is confined almost entirely to the surface of the bowlders.
>
> The deposit is worked in an open pit. The ore and accompanying clay are loosened by blasting and shoveled into small cars, which dump into a steeply inclined sluiceway with a stream of water. This carries the ore to a log washer at the base of the hill and at the same time frees it from much of the associated clay. After passing through the washer the ore is separated into three grades by hand picking. The highest grade contains some iron oxide, but merely as a thin film on the outside, which may be removed readily by acid. The inferior varieties contain more or less iron oxide disseminated throughout their mass, making its complete separation expensive and interfering with its utilization for certain purposes.
>
> Work has been in progress about six months, and during this time more than 1,000 tons of barite, valued at approximately $4,000, have been removed. The deposits will in all probability prove fairly extensive, and the future prospect of the industry seems good.

*Kentucky.*—Predictions made in this report for 1906 that the production of this State would be increased have been fulfilled. A new mill built at Nicholasville by the Jessamine Barytes Company began operations in July, 1907, and handled the production of the company's mines in central Kentucky. Newly opened mines of barytes and lead in Bourbon County produced some barytes, and it is expected that a mill will be erected by the owners, the Kentucky Mining and Development Company. The Dix River Barytes Company has produced considerable barytes from Boyle and Lincoln counties, and holds large undeveloped deposits in Garrard County.

*Missouri.*—Six new mines were reported producing barytes in this State, three being in Washington County, two in Cole County, and one in Morgan County, 10 miles south of Versailles, in a locality where there had been no barytes mined for twenty years. Missouri still continues to be a heavy producer, and contains large supplies of undeveloped barytes awaiting transportation facilities to make them available.

*Nevada.*—It is reported[b] that development was begun in 1907 near Blair, Nev., on a promising vein of barytes which carries galena as the only other constituent, and it is proposed to build a mill for the separation and recovery of both these minerals.

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[a] Hayes, C. W., and Phalen, W. C., A commercial occurrence of barite near Cartersville, Ga., Bull. U. S. Geol. Survey No. 340-M, 1908, pp. 3-7.

[b] Judd, Edw. K., Barytes: Eng. and Min. Jour., January 4, 1908.

*North Carolina.*—North Carolina reports a larger production than in 1906, four firms having produced barytes, as compared with one producer in 1906. The old Lawton barytes mine, 5 miles south of Bessemer City, Gaston County, was reopened about September 1, 1907, under lease by the Clinch Valley Barytes Company, and was operated about three months. This property was visited by Mr. D. B. Sterrett, of the United States Geological Survey, who noted the following points in regard to the occurrence of the barytes and the method of working it:[a] The barytes is disclosed by two main workings about 200 yards apart on opposite sides of a small stream. At the south working one vein is encountered; at the north working there are two parallel or forking veins. All the veins strike about N. 10° to 15° E. Their range in thickness is 2½ to 6 feet, as exposed in the workings. The country rock is fine silvery quartzose sericite schist. Hard, coarse cyanite gneiss outcrops boldly 100 to 200 feet to the west. Minerals associated with the barytes are quartz, galena. sphalerite, pyromorphite, and lead alteration products, and stains of iron and manganese oxides. The barytes is granular and sometimes more coarsely crystalline than marble, and in places it shows cleavage surfaces 2 inches across.

Adjoining the Lawton mine on the north are other old barytes workings, and at a distance of one-third of a mile east of north are still more old workings or test shafts with a small outcrop in the road. At several places extending through a distance of nearly a mile west of south, mining of barytes has been carried on, and in some of these openings there were two parallel veins. At one place hard cyanite gneiss outcrops within 25 feet to the west of the barytes vein.

Doctor Pratt[b] considers that the barytes veins are lenticular in shape, and that they represent the filling of fissures and crevices in the schist, which may have been caused by the faulting or tearing apart of the rock.

The operations at the Lawton mine comprised retimbering of the old 6-foot by 8-foot shaft south of the stream. This shaft is 50 feet west of the vein. The workings on the north side consist of a new shaft, 5½ feet by 8 feet, started some 75 feet east of the main vein. The shaft was, when visited, 20 feet deep and was to be sunk 150 feet, with a cross-cut level at a depth of 75 feet to the vein. Heavy timbering was being used in the shafts and permanent improvements, such as the erection of shop, sawmill, office, and other buildings were being made on the property.

*South Carolina.*—No production was reported from this State, but operations were begun in the fall of 1907 and soon again suspended at the old barytes mines at Kings Creek. The deposits here are about 13 miles southwest of the Lawton mine in North Carolina, but follow the same general trend of rock formations as the Lawton veins.

*Tennessee.*—Although no new deposits of barytes were reported as having been discovered or opened up during 1907 in East Tennessee, the general trade conditions were good, and apparently the business depression of the latter part of the year seems to have been felt less keenly by the barytes industry here than in States farther west. The production as reported to the Survey was increased to nearly four times that of 1906. Deposits in Sevier County are reported to contain ample reserves awaiting better transportation facilities.

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[a] See also Pratt, Joseph Hyde, The Mining industry in North Carolina during 1901: North Carolina Geol. Survey, Economic paper No. 6, 1902, pp. 62-66.

[b] Op. cit.

*Virginia.*—Up to the middle of the year the demand for barytes was very strong, greater than some producers could meet, but in the last half of the year the production was greatly curtailed. Some of the deposits situated near transportation lines are becoming depleted, while others, as yet little worked, are so inaccessible as to render the cost of operation prohibitive at present. With extension of railroad facilities an increased output from this State will become possible.

The geology of the Virginia barytes deposits is described by Watson,[a] who groups the deposits of the States into three areas unlike geologically: (1) those of the red shale, sandstone series of Triassic age; (2) those of the crystalline metamorphic area, the age relations of the rocks being unknown, but probably pre-Cambrian for the most part; and (3) those of the Valley region, associated for the most part with the Cambro-Ordovician limestone (Shenandoah) or its residual clay. Areas 1 and 2 are in the Piedmont province, while 3, as its grouping indicates, is in the great Appalachian valley.

In the Triassic area barytes has been mined in Prince William County about 4 miles south of east from Catlett, Fauquier County. Here it is associated with red shale and impure limestone, usually filling fractures reported to be 4 to 8 feet wide in the red shale, but also in thin, tabular, cleavable masses in the limestone.

In the crystalline area barytes has been noted in nine counties, but the principal production has been from Campbell, Pittsylvania, Bedford, and Louisa counties. In the Campbell-Pittsylvania area the barytes occurs in intimate association with the crystalline limestone in irregular, lenticular bodies or pockets, which measure from 100 to 200 feet, replacing the limestone. There is also present immediately below and above the limestone a variable thickness of a nearly black, manganiferous iron clay (umber), usually preserving the foliation of the original rock from which it was derived. Through this black clay nodules of barytes are distributed. In the Bedford County area the barytes occurs in a schistose, coarse-grained granite, filling a fracture. In Louisa County the ore occurs in pockets having a thickness of about 3 feet where worked. It probably represents a filling in irregular fractures in the crystalline schists.

In the Valley region of southwest Virginia the barytes is in association with the limestone or its residual clay. In places it fills fractures in the limestone, and it also replaces the limestone to some extent. In the clay it is found in nodules irregularly distributed through the clay. The Valley region counties in which barytes occurs are Russell, Tazewell, Smyth, and Wythe, although no mining has been done in the last-mentioned county.

The methods of mining barytes in southwest Virginia as noted by Mr. Watson are simple, and consist mostly of surface workings. In the crystalline area east of the Blue Ridge the ore is won by vertical-timbered shafts and drifts which follow the direction of the ore bodies. The greatest depth yet reached at any mine in the State is 160 feet in a shaft at the Hewitt mine in Campbell County.

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[a] Watson, Thomas L. Geology of the Virginia baryte deposits: Bi-monthly Bull. Am. Inst. Min. Eng. No. 18, November, 1907, pp. 953-976.

## PRODUCTION.

In 1907 the quantity of crude barytes reported as mined in the United States was 89,621 short tons, valued at $291,777. This value is that of the crude barytes at the mines, hand cobbed, sorted, and ready for shipment to the mills. This production shows an increase in quantity of 39,390 short tons, and in value of $131,401, over the output for 1906, which was 50,231 short tons, valued at $160,367. The price per ton shows the following steadily increased averages since 1904: 1904, $2.66; 1905, $3.08; 1906, $3.19, and 1907, $3.25. The apparently large increase of more than 78 per cent in quantity, and of nearly 82 per cent in value, is perhaps the result of three conditions: First, it is possible that reports were not secured from all producers in 1906 and that the actual production was slightly in excess of the figures given for that year; second, several new producers have entered the field since the close of 1906; and third, many new deposits have been opened by steady producers, who, individually, report largely increased outputs. If business conditions had remained normal throughout the year, and there had been no shut-downs in the autumn, the production would doubtless have passed the 100,000-ton mark. As it is, the year 1907 proved to be the record year in the barytes industry, 1904 holding the previous record of 65,727 short tons. A curtailment of production in 1908 is not improbable.

The total quantity of barytes reported as refined by mills in Kentucky, Missouri, North Carolina, Tennessee, and Virginia was 47,399 short tons, valued at $691,636, an average price per ton at the mills of $14.59. This quantity probably falls below the actual tonnage of barytes from mines in the United States that was milled in this country, although owing to the quantities included in unsold stocks it is certain that the discrepancy is not so great as would appear on first inspection of the totals. Considerable foreign barytes, especially from Canada, is annually milled in the United States, but at present records are not available as to the exact quantities.

Prices per short ton quoted by dealers toward the close of 1907 were about as follows: Foreign, first-class, water-floated, $21.50; domestic, first-class, water-floated, $20.50; domestic, first-class, dry-ground, $18 to $20; domestic, off-color, $13.50 to $17.50.

*Production of crude barytes in the United States, 1905-1907, by States, in short tons.*

| State. | 1905. | | | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. |
| Missouri | 26,761 | $84,095 | $3.14 | 28,869 | $93,479 | $3.24 | 44,039 | $162,450 | $3.69 |
| North Carolina | 5,519 | 21,545 | 3.90 | (a) | (a) | .......... | 5,785 | 18,855 | 3.26 |
| Tennessee | b 9,487 | 15,325 | 1.62 | 5,247 | 8,782 | 1.67 | 20,861 | 37,138 | 1.78 |
| Virginia | 6,468 | 27,838 | 4.30 | 11,775 | 45,336 | 3.85 | 9,254 | 32,833 | 3.55 |
| Other States | .......... | .......... | .......... | c 4,340 | 12,770 | 2.94 | d 9,682 | 40,492 | 4.18 |
| Total | 48,235 | 148,803 | 3.08 | 50,231 | 160,367 | 3.19 | 89,621 | 291,777 | 3.26 |

[a] Included in other States.
[b] Includes a small production from Kentucky.
[c] Includes the production of Alabama, Kentucky, and North Carolina.
[d] Includes the production of Georgia and Kentucky.

*Production of crude barytes, 1882–1907.*

| | Short tons. |
|---|---|
| 1882 | 22,400 |
| 1883 | 30,240 |
| 1884 | 28,000 |
| 1885 | 16,800 |
| 1886 | 11,200 |
| 1887 | 16,800 |
| 1888 | 22,400 |
| 1889 | 21,460 |
| 1890 | 21,911 |
| 1891 | 31,069 |
| 1892 | 32,108 |
| 1893 | 28,970 |
| 1894 | 23,335 |
| 1895 | 21,529 |
| 1896 | 17,068 |
| 1897 | 26,042 |
| 1898 | 31,306 |
| 1899 | 41,894 |
| 1900 | 67,680 |
| 1901 | 49,070 |
| 1902 | 61,668 |
| 1903 | 50,397 |
| 1904 | 65,727 |
| 1905 | 48,235 |
| 1906 | 50,231 |
| 1907 | 89,621 |

## IMPORTS.

A review of the situation with regard to the duty on precipitated barium carbonate shows that it presents a new phase since the issuance of this report for 1906. The tariff act of 1897, paragraph 489, places upon the free list "Baryta, carbonate of, or witherite." Witherite is the natural carbonate of baryta, a mineral substance, and as such was plainly entitled by the intent of the act to be exempt from duty as a raw, or unmanufactured, material. The chemical salt, precipitated carbonate of baryta, which is not witherite, but a manufactured chemical compound similar to witherite in chemical composition rather than in physical character, and not necessarily made from witherite as a base, was for a time brought in duty-free under the interpretation that paragraph 489 covered the chemical compound barium carbonate. On November 16, 1901, the Board of General Appraisers held that precipitated carbonate of baryta was dutiable at the rate of 25 per cent ad valorem as a chemical compound under the provisions of paragraph 3 of the act of July 24, 1897, which requires that all chemical compounds not specifically provided for in this act shall be assessed 25 per cent ad valorem.

The United States circuit court for the southern district of New York, in the case of Gabriel & Schall (T. D. 24331), reversed this decision of the Board and held that said article was free of duty under the provisions of paragraph 489 of said act. On July 26, 1907, the Treasury Department instructed (see T. D. 27525) the collector of customs at New York to assess duty again upon precipitated carbonate of baryta at the rate of 25 per cent ad valorem under paragraph 3 of the act of July 24, 1897. This decision has been once more protested against (Protest 277208 of Gabriel & Schall, New York), and the decision of the Board (No. 18633), rendered March 31, 1908, is as follows:

> Lunt, *General Appraiser:* Carbonate of baryta, precipitated, which was classified at the rate of 25 per cent ad valorem under paragraph 3 of the tariff act of 1897 as a chemical salt, is claimed to be free of duty under paragraph 489 as "baryta, carbonate of, or witherite." In other words, the importers contend that paragraph 489 is not limited to witherite but extends to an article known commercially as carbonate of baryta. This contention was decided favorably to the importers in Gabriel & Schall *v.* United States (121 Fed Rep., 208), where the court had before it merchandise identical with that here in issue.
>
> Witherite is a mineral ore, found in the southern part of Scotland, and ranges from 78 to 94 per cent in purity. Carbonate of baryta, precipitated, is a highly finished

> article, 99 per cent pure, the production of which requires such a chemical manipulation that its identity as witherite is lost. It is our opinion that it was never the intent of Congress to admit free of duty a manufactured article when the raw material from which it is produced is admitted free; and as stated in G. A. 5026 (T. D. 23364), citing United States *v.* Eschwege (98 Fed. Rep., 600) and In re Schallenberger (72 Fed. Rep., 491), "the general purpose of the law is to make more advanced articles dutiable at higher rates." This statement is correct when we consider that the underlying principle of our tariff act is protection to American industries.
>
> As an original proposition our conclusion would have been different from that in Gabriel & Schall *v.* United States (supra), but under the doctrine of stare decisis it is incumbent on the Board to follow the decision of a superior appellate court, where the same issue was raised and where the introduction of new testimony before the Board, which was not before the court, does not justify a departure from the decision of the court. G. A. 5600 (T. D. 25066); G. A. 6039 (T. D. 26368).
>
> Conforming to the decision in Gabriel & Schall *v.* United States (supra), we sustain the claim in the protest and reverse the decision of the collector.

The Treasury Department has appealed from this decision and is still levying duty upon precipitated barium carbonate at the date of writing (May 4, 1908).

If it were the intent of the act of 1897 to admit duty-free the mineral witherite only, there would seem to be necessity for clearer definition in the wording of the act, which could be accomplished by the insertion of the word "natural" in paragraph 489, causing it to read "Baryta, natural carbonate of, or witherite." If, on the other hand, the intent was to admit duty-free the chemical salt, carbonate of baryta, as well as witherite, then the act should read: "Baryta, precipitated carbonate of, and witherite."

Producers of barytes are interested in this matter, since the precipitated carbonate can be produced from barytes as a base by means of chemical processes, and it is reported that mills which have been equipped to produce the carbonate have been able to manufacture it profitably.

Precipitated barium carbonate is used as a reagent in analytical chemical work, and also in glass making to impart luster and brilliancy to glass.

The imports of barytes for consumption during the last five years have been as follows:

*Barytes imported and entered for consumption in the United States, 1903–1907, in short tons.*

| Year. | Manufactured. | | Unmanufactured. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| 1903 | 5,716 | $48,726 | 7,105 | $22,777 |
| 1904 | 6,630 | 48,658 | 7,492 | 27,363 |
| 1905 | 4,803 | 39,803 | 14,256 | 62,459 |
| 1906 | 4,807 | 37,296 | 9,190 | 27,584 |
| 1907 | 11,207 | 96,542 | 20,544 | 76,883 |

*Value of the imports of barium compounds in 1905, 1906, and 1907.*

| Barium compound. | 1905. | 1906. | 1907. |
|---|---|---|---|
| Witherite, barium carbonate | $45,073 | $55,405 | $24,552 |
| Barium binoxide | 111,856 | 152,403 | 167,519 |
| Barium chloride | 47,386 | 65,242 | 79,333 |
| Blanc fixe, or artificial barium sulphate | 53,112 | 61,961 | 85,713 |
| Total | 257,427 | 335,011 | 357,117 |

## BARYTES INDUSTRY IN CANADA.[a]

### OCCURRENCE.

In Ontario barytes veins occur on McKellar Island, near the northwest shore of Lake Superior. The main vein is reported to be about 60 feet wide, to consist of coarsely crystalline calcite and barytes with some quartz, and to be inclosed in a dark-green, coarse-grained trap rock. This material has been worked and the product shipped to the United States. About 4 miles west of Kingston a vein of barytes varying in width from a few inches to over 3 feet is reported to extend nearly 14 miles. This vein cuts Ordovician cherty and shaly limestone. The barytes is associated with calcite. Many other occurrences of the mineral have been noted in Ontario.

In Quebec many occurrences of barytes are known, among which the vein worked by the Canada Paint Company in Hull township, Wright County, is worthy of note. This vein has been followed for 300 feet and to a depth of 20 feet. Barytes has been shipped from both New Brunswick and Newfoundland.

In Nova Scotia workable deposits occur on the Gulf shore of Cape Breton, north of Cheticamp Island, also inland about Lake Ainslie. The Cheticamp deposits lie in veins traversing pre-Cambrian schists. Associated with the barytes are quartz, calcite, and fluorite, with hematite in the joint planes. The fluorite is evidently rather abundant at this locality. In the Lake Ainslie district the barytes occurs in a group of nearly parallel veins filling fracture openings in granular and highly quartzitic felsite, probably of pre-Cambrian age. In both the Lake Ainslie and Cheticamp districts the country rocks are bordered or cut by intrusives. Analysis of Lake Ainslie barytes showed barium sulphate, 94.20 per cent; calcium sulphate 0.02 per cent; calcium carbonate, 4.44 per cent; silicia, 0.05 per cent; ferric oxide, 0.11 per cent; and alumina, 0.04 per cent.

On Bass River in the Five Islands district, N. S., are important barytes deposits which occur in veins in crushed and metamorphosed slates. The principal bodies of barytes occur in a zone about 70 feet wide extending in a generall direction northwest from the river. The rock in this zone is very much crushed, and is recemented by calcium carbonate which in places lines cavities in the veins. The barytes veins have well-defined walls but show no regular course or position. They range in width from a few inches to 4 feet, with local enlargements 10 to 15 feet in thickness. A large irregular mass exposed in an open cut consists of barytes filling voids in brecciated slate and inclosing fragments of slate. The barytes found here seems to be of unusual purity. It is crystalline, and only slightly yellow on the outer surface and cleavage faces, while selected specimens are of pure white, barium sulphate. Analysis of a general sample from the bin at the mine gave the following percentages: Loss on ignition, 0.18; silicia, 0.95; iron sulphide, 0.07; alumina, 0.02; calcium oxide, 0.02; magnesia, 0.22; barium sulphate, 98.54. Underground mining work was carried on at this deposit between 1866 and 1871 with reported production of 2,000 to 3,000 tons annually, but has since been suspended, although the deposits are known to be valuable. Recently work has been resumed, and it is expected that the mines will shortly begin shipment.

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[a] Data from Poole, Henry S., The barytes deposits of Lake Ainslie and North Cheticamp, N. S.: Bull. Geol. Survey Canada No. 953, 1907; and Hutchinson, W. Spencer, Barytes deposits at Five Islands N. S.: Eng. and Min. Jour., November 2, 1907, pp. 825-826.

### MANUFACTURE.

In Nova Scotia there are at present two mills preparing barytes for market, one in Halifax, the other at Dartmouth. At the Halifax mill the material is hand-cobbed and separated into three grades, "white," "selected," and "off-color." Then it is broken, crushed, ground with buhrstones, and packed into barrels. The small quantities of fluorite which find their way into the material are not considered detrimental to paints, as the fluorite grinds white. At the Dartmouth mill the barytes is broken, bleached by acid, drained, and washed, and afterwards pulverized, and finally ground between horizontal revolving granite stones and French buhrs.

Crude material is also shipped by the Ainslie Mining and Railway Company (Limited) to the United States, where it is washed, bleached, and milled at the works of the company in Long Island City, N. Y.

### PRODUCTION.

According to the preliminary report on the mineral production of Canada in 1907, there were produced in that year 2,016 short tons of barytes, valued at $4,500. This is a decrease from the production of 1906, which was reported as 4,000 short tons, valued at $12,000.

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## STRONTIUM.

The most common ores of strontium are celestite, the sulphate of strontium ($SrSO_4$), and strontianite, the carbonate of strontium ($SrCO_3$). Celestite occurs associated with limestones, and also with beds of clay, rock, salt, gypsum, and deposits of barytes and of sulphur. Localities where it has been observed in the United States are on Drummond Island, Lake Huron; Put in Bay, Lake Erie; at Schoharie, Lockport, and Rossie, N. Y.; Blair County, Pa.; Brown County, Kans., and on Mount Bonnell, near Austin, Tex. Strontianite occurs also in the latter deposit as an alteration product. Recently the presence of strontium sulphate in association with barytes has been reported from a vein on Kentucky River near Brooklyn, and also from a vein near Danville, Ky., on the property of the Dix River Barytes Company. Analyses made by Ledoux & Co., of New York City, on three samples of this ore show, respectively, 7.12 per cent, 14.36 per cent, and 26.84 per cent of strontium sulphate, the rest of the material being mainly barium sulphate. This is of interest, at least from a mineralogical point of view.

There are a few known occurrences of strontium ores in Canada.[a] Strontianite is reported to occur in veins from 4 to 6 inches thick in Chazy limestone on the south shore of Ottawa River in Nepean township, and celestite to occur in Ontario, as follows: In the township of Lansdowne an important vein of crystalline material; in Bagot township; in the city of Kingston, in Black River limestone; in Caledon township, in Niagara limestone; and in Quebec, in the township of Hawkesbury.

The chief strontium mines are at Strontian, Scotland; in Yorkshire, England; at Giants Causeway, Ireland; in Saxony, in Saltzburg, and in the Hartz Mountains.

Strontium, in the form of the hydroxide, is of value in the refining of beet sugar, and as the nitrate, in the manufacture of pyrotechnic supplies. Barium hydroxide is used to a large extent, on account of its lower cost, in place of strontium hydrate, in the beet-sugar industry, although the barium compound is said to be of a poisonous nature. Probably because of the cheapness of barytes the strontium ores have not yet been worked on a commercial scale in America.

### IMPORTS.

Oxide of strontium, valued at $1,242, was the only importation of strontium compound reported by the Bureau of Statistics for 1907. Considerably larger quantities of the nitrate are believed to be imported into the United States, and it probably comes in as unclassified chemical material.

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[a] Poole, Henry S., op. cit., pp. 41-43.

# MINERAL PAINTS.

By Ernest F. Burchard.

## INTRODUCTION.

The mineral paints considered in this chapter consist of three classes: (1) Natural mineral products which after mechanical treatment, such as cleaning and grinding, are either used directly as pigments or are first roasted to give certain desired colors; (2) chemical products made directly from ores, and (3) secondary chemical products that pass through several metallurgical and chemical processes in their preparation from the original ores.

Class (1) comprises ocher, umber, sienna, hematite and limonite (metallic paints and mortar colors), slate, and shale. Many other minerals or mineral products are used in the paint trade, such as asbestos and its derivatives, asphalt, barytes, clay, gypsum, magnesite, silica, talc, and whiting (ground chalk), but they are not considered here, since they are reported elsewhere in this volume.

Class (2) comprises zinc oxide, leaded zinc oxide, zinc lead, sublimed white lead, and sublimed blue lead.

Class (3) comprises the secondary chemical products, basic carbonate white lead, litharge, red lead, orange mineral, lithophone, and Venetian red. Collection of the statistics of production of these latter pigments does not, strictly speaking, come within the scope of this report, but it has been considered advisable to give the reported production, since these figures are desired by many mineral-paint producers for purposes of comparison.

## PRODUCTION.

In 1907 the total production of the natural pigments—ocher, umber, sienna, metallic paints, mortar colors, slate, and shale—and of those produced directly from the ores, consisting of zinc oxide, zinc lead, sublimed white lead, and sublimed blue lead, reported to the Survey amounted to 143,757 short tons, valued at $9,469,818, as compared with 140,713 short tons, valued at $8,160,836, in 1906, an increase of 3,044 short tons in quantity and of $1,308,982 in value. In the tables for 1906 and 1907 the production classified under "Other pigments" has been omitted, since the substances so classified consisted almost entirely of color lakes, that is, pigments produced by the combination of a dye with a mineral base. Certain chemical colors were also included under the caption "Other pigments," and these have been omitted since their preparation does not bear any close relation to the production of the raw minerals from which they have been derived.

The following table shows the production of these various mineral paints from 1904 to 1907, inclusive:

*Production of mineral paints, 1904–1907, in short tons.*

| Kind. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Ocher | 16,826 | $110,602 | 13,402 | $126,351 | 15,482 | $148,049 | 16,971 | $164,742 |
| Umber<br>Sienna | 522 | 12,960 | 689 | 17,004 | 657 | 17,394 | 730 | 19,309 |
| Metallic paint | 19,357 | 204,377 | [a]16,489 | 176,722 | 17,992 | 204,026 | 16,225 | 195,176 |
| Mortar colors | 7,525 | 84,426 | 10,494 | 120,430 | 10,309 | 111,720 | 10,490 | 110,719 |
| Sublimed blue lead | | | | | | | 1,211 | 135,632 |
| Sublimed white lead | 6,477 | 550,587 | 6,977 | 732,585 | 7,988 | 958,440 | 8,700 | 1,026,600 |
| Zinc lead | 5,779 | 404,530 | 6,779 | 471,530 | 8,124 | 681,292 | 13,516 | 1,286,440 |
| Zinc oxide | 63,363 | 4,808,482 | 68,603 | 5,520,240 | 74,680 | 5,999,375 | 71,784 | 6,490,660 |
| Slate[b] | 5,370 | 53,709 | 5,181 | 44,108 | 5,481 | 40,540 | 4,130 | 40,540 |
| Other pigments | 2,736 | 27,360 | 10,344 | 240,318 | | | | |
| Total | 127,955 | 6,257,033 | 138,958 | 7,452,288 | 140,713 | 8,160,836 | 143,757 | 9,469,818 |

[a] Includes a small quantity of unground material.

[b] Slate and shale ground for pigments.

## OCHER, UMBER, AND SIENNA.

### PRODUCTION.

The quantity of ocher reported to the Survey as having been mined in the United States in 1907 was 16,971 short tons, valued at $164,742; in 1906 there were reported 15,482 short tons, valued at $148,049—an increase in 1907 of 1,489 short tons in quantity and of $16,693 in value. The relative rank of the States as producers remains practically the same as in 1906. Had it not been for the general business depression in the autumn of 1907, the year's production would probably have shown a much larger increase. There is a steadily increasing demand for ocher in the manufacture of oilcloths and linoleums, a large proportion of the production of this mineral from Georgia and Vermont now being taken by makers of those fabrics.

The combined production of umber and sienna in 1907 amounted to 730 short tons, valued at $19,309, as compared with 657 tons, valued at $17,394, in 1906. The production of these substances therefore shows a moderate increase for the year of 73 tons in quantity and of $1,915 in value.

The production of ocher by States for the last four years is shown in the following table:

*Production of ocher, 1904–1907, by States, in short tons.*

| State. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| **California** | 412 | $4,750 | 780 | $5,900 | 500 | $4,470 | 450 | $3,970 |
| **Georgia** | 4,752 | 44,142 | 4,209 | 43,481 | 5,550 | 58,350 | 5,600 | 57,100 |
| **Pennsylvania** | 4,077 | 29,355 | 7,789 | 72,360 | 8,597 | 79,244 | 8,047 | 76,816 |
| **Vermont** | 2,176 | 5,200 | (a) | (a) | (a) | (a) | 682 | 6,638 |
| **Other States** | [b] 5,409 | 27,155 | [c] 624 | 4,610 | [d] 835 | 5,985 | [e] 2,192 | 20,218 |
| **Total** | 16,826 | 110,602 | 13,402 | 126,351 | 15,482 | 148,049 | 16,971 | 164,742 |

[a] Included in "Other States."

[b] Arkansas, Iowa, Virginia, and Indian Territory.

[c] Iowa, Vermont, and Virginia.

[d] Alabama, Iowa, Kentucky, Vermont, and Virginia.

[e] Iowa, Kentucky, and Virginia.

The total production of ocher and of umber and sienna in the United States from 1903 to 1907, inclusive, is as follows:

*Production of ocher and of umber and sienna, 1903–1907, in short tons.*

| Year. | Ocher. | | Umber and sienna. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 12,524 | $111,625 | 666 | $15,367 | 13,190 | $126,902 |
| 1904 | 16,826 | 110,602 | 522 | 12,960 | 17,348 | 123,562 |
| 1905 | 13,402 | 126,351 | 689 | 17,004 | 14,091 | 143,355 |
| 1906 | 15,482 | 148,049 | 657 | 17,394 | 16,139 | 165,443 |
| 1907 | 16,971 | 164,742 | 730 | 19,309 | 17,701 | 184,051 |

## IMPORTS.

The imports of ocher, umber, and sienna for the last five years are shown in the following tables:

*Imports of ocher, 1903–1907, in pounds.*

| Year. | Crude. | | Dry. | | Ground in oil. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | | | 9,839,999 | $99,269 | 20,335 | $1,178 | 9,860,334 | $100,447 |
| 1904 | | | 9,430,916 | 93,137 | 12,756 | 583 | 9,443,672 | 93,720 |
| 1905 | | | 10,616,496 | 91,673 | 15,985 | 880 | 10,632,481 | 92,553 |
| 1906 | | | 11,316,868 | 97,830 | 113,049 | 2,233 | 11,429,917 | 100,063 |
| 1907 | 127,117 | $1,312 | 11,850,372 | 102,194 | 14,482 | 1,079 | 11,991,971 | 104,585 |

*Imports of umber, 1903–1907, in pounds.*

| Year. | Dry. | | Ground in oil. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 2,159,914 | $17,685 | 9,656 | $587 | 2,169,570 | $18,272 |
| 1904 | 2,261,793 | 19,727 | 13,133 | 784 | 2,274,926 | 20,511 |
| 1905 | 2,580,501 | 20,763 | 6,783 | 461 | 2,587,284 | 21,224 |
| 1906 | 2,948,539 | 23,732 | 6,028 | 418 | 2,954,567 | 24,150 |
| 1907 | 3,395,690 | 26,502 | 2,569 | 211 | 3,398,259 | 26,713 |

*Imports of sienna, 1903–1907, in pounds.*

| Year. | Dry. | | Ground in oil. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 1,873,532 | $28,447 | 1,387 | $123 | 1,874,919 | $28,570 |
| 1904 | 1,286,301 | 22,118 | 5,770 | 396 | 1,292,071 | 22,514 |
| 1905 | 1,737,909 | 26,097 | 2,886 | 227 | 1,740,795 | 26,324 |
| 1906 | 1,941,664 | 32,673 | | | 1,941,664 | 32,673 |
| 1907 | 2,176,566 | 34,752 | 14,629 | 864 | 2,191,195 | 35,616 |

## WORLD'S PRODUCTION OF OCHER.

The following table gives the output of ocher in the principal producing countries of the world for the years 1902 to 1906, inclusive, as far as the statistics are available:

*World's production of ocher, 1902–1906, in short tons.*

| Year. | United States. | | United Kingdom. | | France. | | German Empire. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 16,565 | $145,708 | 18,999 | $112,030 | 38,326 | $361,687 | 15,374 | $27,863 |
| 1903 | 12,524 | 111,625 | 15,848 | 82,839 | 37,524 | 652,811 | 21,479 | 53,291 |
| 1904 | 16,826 | 110,602 | 17,976 | 88,656 | 38,520 | 639,192 | 21,062 | 26,280 |
| 1905 | 13,402 | 126,351 | 18,185 | 75,238 | 41,667 | 655,003 | 20,175 | 40,369 |
| 1906 | 15,482 | 148,049 | 15,915 | 71,358 | 39,187 | 275,266 | 24,586 | 72,920 |

| Year. | Canada. | | Belgium. | | Japan. | | Cyprus. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 4,955 | $30,495 | 220 | $800 | .......... | .......... | [a] 2,093 | $4,840 |
| 1903 | 6,226 | 32,440 | 220 | 772 | .......... | .......... | [a] 3,506 | 7,499 |
| 1904 | 3,925 | 24,995 | 496 | 1,592 | 192 | $764 | [a] 2,540 | 5,531 |
| 1905 | 5,105 | 34,675 | 683 | 2,084 | 23 | 243 | [a] 3,092 | 6,817 |
| 1906 | 6,837 | 36,955 | 276 | 243 | .......... | .......... | [a] 2,526 | 6,258 |

[a] Umber exports.

## GEORGIA OCHER DEPOSITS.

In a recent publication[a] Prof. T. L. Watson has described the deposits of ocher which now are producing about one-third of the domestic supply of this mineral. The field work for this report was completed in 1902, but it represents probably the most recent detailed examination of the Georgia ocher field.

*Location.*—According to Watson the ocher deposits occupy a narrow strip 1 to 2 miles wide and about 8 miles long, extending in a nearly north-south direction about 1 mile east of Cartersville. One of the best natural exposures of the ocher beds is afforded by the cut made by Etowah River across the axis of the belt, nearly 2 miles southeast of Cartersville, and advantage has been taken of the favorable conditions to establish mines and works at this place.

*Geologic relations and origin.*—The ocher is associated with the Weisner quartzite and siliceous shale (Cambrian), either embedded in the rock or lying in the residual clay derived from the decay of the beds. The ocher appears to occupy an extensively shattered zone in the quartzite. According to Hayes[b] the ocher forms in the unaltered, shattered quartzite a series of irregular, branching veins, which in places expand into bodies of such size that, when the ocher is removed by mining, rooms from 6 to 10 feet in diameter are sometimes left, connected by narrow winding passages. He further observes that the contact between the ocher and the inclosing quartzite is not sharp and distinct, but shows, instead, a more or less gradual transition from the hard and vitreous quartzite to the soft ocher.

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[a] Watson, Thomas L., A preliminary report on the ocher deposits of Georgia: Geol. Survey of Georgia, Bull. 13, 1906.

[b] Hayes, C. W., Geological relations of the iron ores of the Cartersville district, Georgia: Trans. Am. Inst. Min. Eng., vol. 30, 1901, p. 415.

Watson finds the relations of the ocher in the clays to be in all respects similar to that in the fresh rock. It forms in the inclosing clay a series of irregular, branching deposits which correspond to veins in the fresh rock, and a more or less gradual transition from clay to pure ocher is usually shown.

Microscopic study of the ocher-charged quartzite has shown the presence of much pyrite in the rock. From this fact and others noted in a careful study of the structure and composition of the ocher-bearing rocks, of the relations of the ore deposits to the inclosing rocks, and of the character of the deposits themselves, the conclusion is reached that the iron oxide of the ocher deposits in the Cartersville district was probably derived in part from two different sources: (a) From surface rocks through decay and subsequent leaching and solution of the resulting ferrous salts by percolating waters, and (b) from the pyrite contained in the Weisner quartzite. The deposition of the ocher is thought to have taken place, not by simple filling of cavities and fissures in the rock, but by metasomatic replacement of the original rock.

Associated with the ocher in places are barytes,[a] limonite, and manganese ore.

*Physical properties.*—Physically the ocher varies principally in color. The variation in color, which ranges from dark yellow to light, bright yellow, is thought to depend principally on the amount of clay or argillaceous matter present, and this in turn is dependent on the character of the rock which the ocher replaces. Where the ocher replaces pure quartz rock it is of a light, bright yellow color and contains comparatively little admixed clay, while the material that replaces interbedded siliceous shale in the Weisner formation is found to contain considerable clay and is darker in color and of inferior quality. The bodies of pure ocher consist of yellow powder of extremely fine particles of hydrated ferric oxide, clay-like in character, in which the water content is high and the material is soft enough to be spaded. As the ocher grades from the soft condition through that in which the material is bound together by a siliceous skeleton into hard and firm quartzite, the color gradually fades and finally disappears. The presence of silica exercises but little effect on the appearance of the ocher, and when small traces of manganese oxide are present its effect is to give a slightly greenish tint to the refined ocher.

*Chemical composition.*—The chemical composition of crude and refined ocher from this district is shown in the following table:

*Chemical analyses of Georgia ochers.*[b]

| Character. | $Fe_2O_3$. | $Al_2O_3$. | FeO. | $MnO_3$. | $SiO_2$ (free). | $SiO_2$ (combined). | $H_2O$ (at 105°C.). | $H_2O$ (above 105°C.). |
|---|---|---|---|---|---|---|---|---|
| 1. Crude | 72.29 | 5.55 | 0.46 | 0.87 | 6.65 | 3.98 | 0.55 | 9.22 |
| 2. Do | 56.29 | 10.15 | .39 | .54 | 8.94 | 9.49 | 2.08 | 11.34 |
| 3. Refined | 65.49 | 7.20 | ........ | 1.80 | 7.76 | 6.85 | .40 | 10.50 |
| 4. Do | 54.60 | 6.68 | ........ | 1.50 | 17.42 | 10.08 | .48 | 9.24 |
| 5. Do | 67.37 | 6.85 | ........ | 2.04 | 6.54 | 6.61 | .96 | 9.63 |
| 6. Do | 61.40 | 7.14 | ........ | 2.00 | 11.89 | 5.84 | .46 | 9.37 |
| 7. Do | 67.32 | 5.86 | ........ | ........ | 9.14 | 6.35 | .78 | 9.60 |
| 8. Do | 62.79 | 6.94 | ........ | ........ | 6.20 | 9.78 | .50 | ........ |

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[a] Hayes, C. W., and Phalen, W. C., A commercial occurrence of barite near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340-M, 1908, pp. 3-7.

[b] Analyses made at N. P. Pratt laboratory, Atlanta, Ga

*Surface indications of ocher.*—The Cartersville district is an area that has undergone atmospheric decay to great depths, and consequently exposures of fresh rock are not common. The mantle of residual decay is thicker in the valley bottoms and on the lowlands than on the ridge tops, and unless fragments of the ocher-bearing quartzite are exposed on the surface the presence of ocher is demonstrated only by natural or artificial cuts or openings. Over much of the district, however, lie scattered fragments and masses of quartzite, more or less highly impregnated with ocher and colored yellow, that have been dislodged from outcropping ledges and reefs of ocher-bearing quartzite. Such fragments, which are locally called "ocher bloom," indicate the presence of workable deposits of ocher. Where ledges and reefs of quartzite appear at the surface careful examination sometimes reveals the presence in them of ocher. Still another surface evidence of the presence of ocher is the occurrence of barytes in the residual clay. Prospecting in localities containing barytes has usually revealed more or less extensive deposits of ocher.

## METALLIC PAINT.

### PRODUCTION.

The production of metallic paint and mortar colors in 1907 as reported to the Survey amounted to 26,715 short tons, valued at $305,895, a slight decrease from the 1906 production, 28,301 short tons, valued at $315,746. In quantity the 1907 production was almost the same as that of 1905, which was 26,983 short tons, but the value in 1907 shows an increase over that of 1905 of $8,743. Pennsylvania still continues to produce the largest quantity of metallic paint. New York is the next largest producer, and the other States maintain practically the same rank as in 1906.

The following table gives the production of metallic paint and mortar colors from 1904 to 1907, inclusive:

*Production of metallic paint and mortar colors, 1904–1907, by States, in short tons.*

| State. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Maryland and Tennessee | [a] 5,292 | $36,071 | 6,209 | $40,192 | 5,625 | $51,800 | 6,038 | $64,020 |
| New York | 4,550 | 53,150 | [b] 7,159 | 76,990 | 7,106 | 79,060 | 6,394 | 70,771 |
| Ohio | 1,750 | 21,300 | 1,589 | 20,360 | [c] 1,929 | 19,360 | [c] 1,341 | 15,471 |
| Pennsylvania | 7,710 | 107,609 | 8,596 | 123,570 | 11,021 | 136,086 | 10,327 | 127,973 |
| Other States | [d] 7,580 | 70,673 | [e] 3,430 | 36,040 | [f] 2,620 | 29,440 | [f] 2,615 | 27,660 |
| Total | 26,882 | 288,803 | 26,983 | 297,152 | 28,301 | 315,746 | 26,715 | 305,895 |

[a] Includes the production of Tennessee only.
[b] Includes a small quantity of unground material.
[c] Includes a small quantity from Connecticut in 1907 and from Connecticut and Vermont in 1906.
[d] Alabama, New Jersey, and Wisconsin.
[e] California, New Jersey, Virginia, and Wisconsin.
[f] California, Illinois, and Wisconsin.

## SLATE AND SHALE.

### PRODUCTION.

Slate and shale are ground for use as pigments in Pennsylvania, New York, Iowa, and Arkansas, the first two States being the principal producers. In 1907 there were reported to the Survey 4,130 short tons, valued at $40,540. This is a decrease in quantity of 1,351 short tons, but an increase in value per ton of about $2.40. No production was reported from Arkansas in 1907.

The following table gives the production of slate and shale ground for pigment from 1904 to 1907, inclusive:

*Quantity and value of slate and shale ground for pigment, 1904–1907.*

| | | | |
|---|---|---|---|
| 1904 | short tons | [a] 5,370 | $53,709 |
| 1905 | do | 5,181 | 44,108 |
| 1906 | short tons | 5,481 | $40,540 |
| 1907 | do | 4,130 | 40,540 |

## PIGMENTS MADE DIRECTLY FROM ORES.[b]

### ZINC-WHITE PIGMENTS.

The relations to the ores from which they are derived of the various pigments that are made directly from ores are of interest here, and the following notes may serve to define the pigments and to outline their properties and the methods by which they are manufactured.

Zinc oxide is the most important of the zinc pigments. This substance is often known to the trade as zinc white, but there are at least three other white zinc pigments sometimes termed "zinc white," viz, leaded zinc oxide, zinc lead, and lithophone.

Zinc oxide, represented by the formula $ZnO$, is a white powder consisting, by weight, of 80.34 per cent zinc and 19.66 per cent oxygen. It is produced by two methods—one known as the French, the other as the American process. In the French process metallic zinc is burned in a current of air, and the product of combustion, zinc oxide, is collected in closed chambers. In the American process ores of zinc mixed with finely powdered coal are burned in a closed furnace over a grate and the product, zinc oxide, after passing through a series of cooling flues, is collected in cloth bags, which retain the white sublimate and permit the fumes to escape. When made from the metal the oxide is nearly chemically pure, but when made from the ore the oxide usually contains lead sulphate, zinc sulphate, and traces of iron and other metals.

The principal types of ore used for making zinc oxide are the franklinite ore of New Jersey, the sphalerite ores of the Mississippi Valley, such as those mined in the Platteville district of Wisconsin and the Joplin district of Missouri, and the sulphide, carbonate, and silicate ores of zinc and lead found in Colorado and New Mexico. There are plants producing the oxide from the ore at Newark, N. J., at Palmerton, Pa., at Mineral Point, Wis., at Joplin, Mo., and at Coffeyville, Kans. Leaded zinc oxide and zinc-lead white are made also at Canon City, Colo. The plant at Joplin, Mo., was built to use local ores, with soft coal as fuel. The high price of pure zinc ores led to the use of an ore which contained some lead, and as an outgrowth of this practice a smelter designed to treat complex Western ores without separating them was built at Coffeyville, Kans., where natural gas is available for fuel. This plant is arranged in two units so that one of them can be operated to make zinc oxide while the other is making leaded zinc oxide or zinc lead, or both units can be employed in making one kind of pigment. The ores used are from Magdalena, N. Mex. They comprise sulphides, carbonates, and silicates of zinc and lead, and may be a combination of any of these, provided that the combined content of metallic zinc and lead does not fall below 30 per cent of the ore. Leaner ores are not profitable to work.

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[a] Includes mineral and carbon black.

[b] The writer is indebted to Messrs. G. B. Heckel, editor of "Drugs, Oils, and Paints," and to Mr. L. S. Hughes, chemist for the Picher Lead Company, for much of this information, which was personally communicated.

Natural gas is used in roasting the ore at the Coffeyville plant, and Arkansas semianthracite coal is used in the oxidizing furnaces. In this process small quantities of copper, gold, and silver are recovered from the ores high in zinc, since they readily pass into the slag while the zinc is being volatilized.

Notable properties of zinc oxide are its extreme whiteness, fineness, and chemical stability. For certain purposes it is said to be improved by the addition of small quantities of coarser reinforcing pigments.

Zinc lead is a white pigment consisting apparently of a molecular combination of zinc oxide and lead sulphate, with small proportions of lead oxide, lead carbonate, and zinc sulphate. It is prepared by sublimation from low-grade zinc-lead ores. This pigment is very fine, amorphous, and uniform in size of its particles. It is not quite so white as zinc oxide.

Leaded zinc oxides are pigments that resemble zinc lead, but contain less lead sulphate. They are made with definite percentages of lead sulphate, usually ranging from 6 to 20 per cent, according to the purpose for which they are to be used. These oxides are produced from Western ores that carry a certain proportion of lead sulphide. In fineness they are similar to zinc oxide, and in whiteness they stand between zinc oxide and zinc lead.

The following analyses of a few zinc-white pigments show their variation in composition:[a]

*Analyses of zinc-white pigments.*

| | $ZnO$. | $ZnSO_4$. | $PbSO_4$. | $PbO$. | Insoluble. | $H_2O$. |
|---|---|---|---|---|---|---|
| Pure zinc oxide, made from spelter | 99.80 | ........ | ........ | ........ | Trace. | 0.20 |
| Zinc oxide, made from silicate ore | 96.81 | 0.15 | 2.75 | ........ | 0.22 | .07 |
| Zinc oxide, made from sphalerite | 89.31 | .96 | 9.33 | 0.27 | .03 | .10 |
| Leaded zinc oxide, made from mixed ores | 77.35 | .13 | 21.01 | 1.38 | .08 | .05 |
| Zinc lead, made from mixed ores | 48.40 | .67 | 50.40 | .32 | .10 | .11 |

Lithophone is not made directly from zinc ores, but is an intimate mixture of precipitated zinc sulphide and barium sulphate (blanc fixe, or "permanent white"). The material is produced by the reaction of solutions of zinc sulphate and barium sulphide, the precipitates from which come down simultaneously and are very intimately mixed. To perfect the material for a pigment it is heated to dull redness and suddenly plunged into cold water, ground in the pulp state, washed, and dried. This material is white, is of fine grain, and possesses body and opacity. It possesses great durability, and is often used in enamel and floor paints. It also finds extensive use in the manufacture of linoleum and shade cloths.

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[a] Scott, W. G. Oxide of zinc: Prize essay published in pamphlet form by the New Jersey Zinc Company, 1907.

## ZINC OXIDE.

### PRODUCTION.

The output of zinc oxide, the principal zinc-white pigment, appears to have decreased slightly in 1907 as compared with the production in 1906. In 1907 there were reported to the Survey 71,784 short tons, valued at $6,490,660, a decrease in quantity of 2,896 short tons, but an increase in value of $491,285. The decrease in quantity is, however, more than offset by the increase in the production of zinc lead, with which is perhaps included some leaded zinc oxide. The capacities of certain of the Western plants have been increased during 1907, and with a resumption of normal trade conditions the output of these pigments will again show an increase.

The following table gives the production of zinc oxide from 1904 to 1907, inclusive:

*Production of zinc oxide, 1904–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1904.....short tons.. | 63,363 | $4,808,482 | 1906....short tons.. | 74,680 | $5,999,375 |
| 1905..........do.... | 68,603 | 5,520,240 | 1907.........do.... | 71,784 | 6,490,660 |

### IMPORTS.

The following table shows the imports of zinc oxide into the United States in the last five years:

*Imports of zinc oxide, 1903–1907, in pounds.*

| Year. | Dry. | | In oil. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 3,487,042 | $171,932 | 166,034 | $16,562 | 3,653,076 | $188,494 |
| 1904 | 2,585,661 | 138,674 | 224.244 | 26,436 | 2,809,905 | 165,110 |
| 1905 | 3,436,367 | 196,220 | 342,944 | 40,542 | 3,779,311 | 236,762 |
| 1906 | 4,191,476 | 251,609 | 292,538 | 36,457 | 4,484,014 | 288,066 |
| 1907 | 5,311,318 | 323,551 | 362,814 | 33,679 | 5,674,132 | 357,230 |

## ZINC LEAD.

The production of zinc lead in 1907 was 13,516 short tons, valued at $1,286,440, as against 8,124 short tons, valued at $681,292, in 1906.

## SUBLIMED WHITE LEAD.

Another pigment that is of interest in this connection, since it is made directly from the lead ore, galena or lead sulphide, is known as sublimed white lead. It is manufactured at Joplin, Mo., from ore produced in that district, by a process similar in principle to that employed for making zinc oxide and zinc lead. Briefly summarized, the method of manufacture is as follows: Lead ore (galena), after having been cleaned at the mine by crushing, washing, and jigging, is ground to a powder, and charged with carbon into a furnace over an open coke fire. The charge is volatilized and in the presence of air the lead sulphide is oxidized to a basic lead sulphate, while some free sulphur dioxide is formed. The basic lead sulphate is thought to be composed of two molecules of lead sulphate ($PbSO_4$), linked to one of lead oxide (PbO). This product, volatile while hot, is cooled by being drawn by suction through a long series of cooling pipes, or "goosenecks," and some settling chambers, and then is collected in bags of the type used for collecting zinc oxide. The aim is to produce a pigment containing 75 per cent of lead sulphate, 20 per cent of lead oxide, and 5 per cent of zinc oxide. Notable properties of this pigment are its great fineness, the uniform size of its particles, and its relative chemical stability or inertness in the presence of coal gas, sulphur fumes, and other noxious gases that quickly darken some paints. It has a snow-white color and is very opaque, but since it is so extremely fine and of amorphous texture it requires blending with coarser pigments to give it "tooth," that is, to prevent it from brushing out too thin.

Sublimed white lead finds use not only in mixed paints, but in putty and in the manufacture of rubber. The production in 1907 was 8,700 short tons, valued at $1,026,600.

### SUBLIMED BLUE LEAD.

In the sublimation of galena a peculiar bluish-gray compound of lead is formed as a by-product, which is known commercially as sublimed blue lead. In the furnace it is known as "fume." Analyses have shown the presence in it of about 2 per cent carbon, 4.5 to 5 per cent lead sulphide, 1 to 2.5 per cent zinc oxide, 0.36 to 1.44 per cent lead sulphite, 50 to 53 per cent lead sulphate, and 37.5 to 41.3 per cent lead oxide.

Sublimed blue lead, besides being used in paint manufacture, is used in the rubber industry. The production in 1907 was 1,211 short tons, valued at $135,632.

## CHEMICAL PIGMENTS AND COLORS.

### PRODUCTION.

Under this head are included basic carbonate of lead, or corroded white lead, litharge, red lead, orange mineral, lithophone, and Venetian red. The production of corroded white lead in 1907 reported to the Survey was 92,216 short tons, in oil, valued at $12,138,932, and 35,035 short tons, dry, valued at $4,309,392. This represents a slight decrease both in quantities and values from the production reported in 1906. Practically the same relations between the quantities and values of lead ground in oil, and dry, are shown in 1906 and 1907.

Litharge was produced to the quantity of 20,838 short tons, valued at $2,854,987. In 1906 the production of litharge and orange mineral were grouped together, but it is possible to report them separately for 1907, and it is found that the production of litharge in 1907 exceeded the combined production of litharge and orange mineral in 1906.

The production of red lead shows a large increase in quantity from 13,808 short tons in 1906 to 20,078 short tons in 1907, and a corresponding increase in value from $1,924,288 in 1906 to $2,802,454 in 1907, the values per ton remaining practically the same.

The production of lithophone in 1907 amounted to 10,275 tons, valued at $750,350, or more than double the production of 1906.

Venetian red shows a decided decrease in quantity, there having been produced in 1906 13,526 short tons, valued at $198,394, while in 1907 7,566 short tons were reported, valued at $134,167; but the value has apparently increased about $3.07 per ton.

In the following table are given the production of these various chemical pigments and colors for the years 1904 to 1907, inclusive:

*Production of corroded white lead, red lead, litharge, orange mineral, lithophone, and Venetian red, 1904–1907, in short tons.*

| | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Corroded white lead: | | | | | | | | |
| In oil | 58,332 | $6,935,620 | 62,767 | $7,577,437 | 93,763 | $12,357,632 | 92,216 | $12,138,932 |
| Dry | 65,014 | 6,821,309 | 73,909 | 8,261,212 | 38,318 | 4,571,618 | 35,035 | 4,309,392 |
| Red lead | 10,271 | 1,206,073 | 16,378 | 2,049,888 | 13,808 | 1,924,288 | 20,078 | 2,802,454 |
| Litharge | 9,839 | 1,084,093 | 19,878 | 2,307,233 | 18,910 | 2,551,346 | 20,838 | 2,854,987 |
| Orange mineral | | | | | | | 669 | 129,410 |
| Lithophone | | | | | 4,300 | 311,500 | 10,275 | 750,350 |
| Venetian red | 7,449 | 137,737 | 6,879 | 137,541 | 13,526 | 198,394 | 7,566 | 134,167 |

## IMPORTS.

The following table gives the quantity and value of the imports of corroded white lead, red lead, litharge, orange mineral, and Venetian red from 1904 to 1907, inclusive:

*Corroded white lead, red lead, litharge, orange mineral, and Venetian red imported, 1904–1907, in pounds.*

| Year. | Corroded white lead. | | Red lead. | | Litharge. | | Orange mineral. | | Venetian red. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1904 | 587,338 | $33,788 | 836,077 | $30,115 | 44,541 | $1,500 | 766,469 | $37,178 | 4,937,397 | $40,270 |
| 1905 | 597,510 | 34,722 | 704,402 | 26,553 | 117,757 | 4,139 | 628,003 | 31,106 | 4,558,998 | 39,585 |
| 1906 | 647,636 | 41,233 | 1,093,639 | 50,741 | 87,230 | 3,737 | 770,342 | 42,519 | 5,432,732 | 43,091 |
| 1907 | 584,310 | 37,482 | 679,171 | 35,959 | 90,475 | 4,386 | 615,015 | 37,793 | 4,738,148 | 37,869 |

## PAINT TESTS.

In connection with the recent popular movement toward paint legislation, the thorough testing of mixed paints has been undertaken by the Paint Manufacturers' Association of the United States, in order to demonstrate the qualities of paints of various classes or types. The results should be of value not only to technical paint men, but to any user of paints. Perhaps their most important use will be to afford a reliable means of comparing the merits of various mixtures of pigments for the information of legislators who are called upon to regulate the labeling and selling of paint products.

In a recent article Mr. G. B. Heckel[a] describes the progress of this series of paint tests, which may be summarized as follows:

The first of these tests was begun nearly two years ago by the North Dakota Agricultural College at Fargo, N. Dak., and, in order to work under varying climatic conditions, additional tests, on a more comprehensive scale, have been initiated at Atlantic City, N. J., and Pittsburg, Pa. Sixteen or more formulas furnished by the paint manufacturers, representing all the popular and successful types of prepared paints on the market, ranging from a base of straight lead and zinc, in varying proportions, to a combination of zinc and barium sulphate, are to be included, with the addition of a number of formulas representing the various pigments and combinations of pigments in common use for painting wood structures, including a dozen or more brands of white lead purchased in the open market, zinc oxides, sublimed white lead, zinc-lead white, lithophone, etc. A series of greens is also being tested at Atlantic City by request of the Philadelphia Master Painters' Association, which finds great difficulty in obtaining a green that will not mildew in this locality. In these formulas all the reenforcing or inert pigments were represented, including silica, calcium carbonate, calcium sulphate, magnesium silicate, etc., the object being to provide formulas which, without duplicating existing paints, would each stand as typical of its class.

Duplicate test fences have been erected at Atlantic City and Pittsburg and the paint to be tested has been applied under uniform conditions to panels of carefully inspected wood. Three coats of paint were applied, and after complete drying of the third coat the panels were screwed to the fence. This will permit their removal for laboratory inspection at any time. At one corner of each panel a small plate of clear glass and a duplicate plate of orange glass in a wood frame has been securely attached and sealed, so as to exclude atmospheric agencies while allowing the light to reach the painted surface below. By this means it is expected to ascertain what effect, if any, the actinic rays of the sun have upon the durability of a paint film.

Great care has been exercised to secure absolute uniformity of conditions and impartiality of execution of the tests, and while it is not expected that the results of these tests will settle finally and conclusively the relative merits of competing pigments and types of paint, it is expected that they will afford much valuable information; and if such tests are extended to other sections of the country they may furnish valuable and suggestive cumulative evidence.

Since the tests as outlined above have just been undertaken, no results are yet available for publication. Observations will be made from time to time, extending over a period of several years, and as results become available they will be published by the Paint Manufacturers' Association. Such information may be obtained from Dr. Robert S. Perry, director of the scientific section of the Paint Manufacturers' Association, and it is expected that the published results will be reviewed in subsequent volumes of Mineral Resources.

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[a] Heckel, G. B., Some important paint tests: Eng. and Min. Jour., May 30, 1908, p. 1099.

## RECENT LITERATURE.

The following list represents a few of the papers and texts that have appeared within recent years dealing with the technology, geology, and statistics of mineral paints and pigments:

Burchard, Ernest F. Southern red hematite as an ingredient of metallic paint: Bull. U. S. Geol. Survey No. 315, pt. 1, 1907, pp. 430–434.

Buskett, Evans W. Manufacture of zinc pigments: Mines and Minerals, November, 1907, pp. 193–194.

Eckel, Edwin C. The production of mineral paints in 1906: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1115–1122.

Gordon, Wm. F. Zinc oxide and zinc-lead pigment manufacture: Eng. and Min. Jour., vol. 83, No. 22, June 1, 1907, pp. 1033–1036.

Hall, Clare H. The chemistry of paint and paint vehicles: D. Van Nostrand Company, New York, 1906, 134 pp.

Hayes, C. W. Geological relations of the iron ores in the Cartersville district, Georgia: Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 403–419.

Heckel, G. B. A paint catechism for paint men: Drugs, Oils, and Paints, Philadelphia, 1907, 43 pp.

Holley, C. D., and Ladd, E. F. Analysis of mixed paints, color pigments, and varnishes: Wiley & Sons, New York, 1908.

Hughes, L. S. Notes on the structure of paint films: Pamphlet published by Picher Lead Company, Chicago, Ill.

——— Fire process pigments and paints: Pamphlet published by Picher Lead Company, Chicago, Ill., also published as An address on Paint, in Lead and Zinc News, May 20, 1907, pp. 5–8.

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Rickard, T. A. The story of the manufacture of white lead paint: Min. and Sci. Press, May 9, 1908, pp. 622–636.

Scott, W. G. The two white leads: Modern Painter, Chicago, January, 1908, pp. 862–866.

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Thompson, Gustave. White lead, its advantages as a paint pigment: Lead and Zinc News, April 29, 1907, pp. 5–9.

Toch, Maximilian. The chemistry and technology of mixed paints: D. Van Nostrand Company, New York, 1907, 166 pp.

United States Refining and Reduction Company. Standard Zinc-Lead White: Pamphlet published by United States Reduction and Refining Company, Colorado Springs, Colo.

Watson, Thomas L. The ocher deposits of Georgia: Bull. 13, Geol. Survey Georgia, 1906, 81 pp.

——— The yellow ocher deposits of the Cartersville district, Bartow County, Ga.: Trans. Am. Inst. Min. Eng., vol. 66, 1903, pp. 643–666.

Willimott, C. W. The mineral pigments of Canada: Bull. 913, Geol. Survey Canada, 1906, 39 pp.

# ASBESTOS.

By J. S. Diller.

## INTRODUCTION.

The United States is the largest manufacturer and consumer of asbestos products in the world, but the asbestos used in its factories comes almost wholly from Canada. The quantity of asbestos mined in the United States is insignificant and plays no appreciable part in the control of the market. The total output for 1907 was only 653 short tons—the smallest annual production since 1896. The cause of this decline is found in the better quality and the greater abundance and accessibility of the Canadian asbestos, which completely dominates the asbestos industry of the United States.

## VARIETIES AND CHARACTERISTICS.

The most general characteristics of asbestos and the ones on which its utility depend are its fibrous structure and its incombustibility, but all the varieties are not equally resistent to heat nor do they possess equal quantity of fiber. The asbestos of commerce includes fibrous minerals of different species, most of which belong to the amphibole group, but the most important mineral is chrysotile, a variety of serpentine.

Amphibole asbestos is generally dull, varies in color from greenish to gray and white, and, though flexible for the most part, has a considerable degree of brittleness. It occurs in ancient crystalline rocks that have been crushed and sheared under great pressure in the process of mountain building, and it appears in three forms. Two of these forms, slip fiber and cross fiber, are veins, and the third is found in large fibrous masses, generally made up of small bunches of asbestos which are more or less divergent and sometimes distinctly radial. For convenience in distinguishing the latter form from the vein fiber (slip fiber and cross fiber), the designation " mass fiber " is proposed for it.

In veins of slip-fiber asbestos the fiber lies parallel to the vein walls and marks a plane of fracture along which the two sides have slipped upon each other and given direction to the development of the fiber. Cross-fiber asbestos extends directly across the vein which it forms. The mass fiber is not in veins, but forms the whole mass of the rock, in which veins of slip or cross fiber may occur. As a matter of fact, however, where mass fiber is best developed veins of slip fiber and cross fiber are rare or entirely absent.

Chrysotile asbestos is for the most part green, rarely yellowish, and the fiber of good quality has a silky luster and sufficient toughness to give it considerable tensile strength, so that it can be spun and woven. It is generally, if not always, associated with massive serpentine, in which its most important form is small cross-fiber veins varying from a mere film to a few inches in thickness, though in some localities there is much slip-fiber chrysotile scattered in thin sheets throughout the rock. The fibers of chrysotile in their original position extend directly across the vein, but subsequent rock movements may make them appear to pass into slip fiber, as at East Broughton, Canada.

## DEVELOPMENT OF THE ASBESTOS INDUSTRY.

The sporadic use of asbestos can be traced back into ancient times, but it was not until about forty years ago that investigations began in Europe to develop its application upon a commercial scale. About the same time specimens of the fine Canadian asbestos were exhibited abroad, and, in 1878, 50 tons were shipped from Canada to England. Soon after this discovery of an enduring source of supply in Canada the advances in the application of asbestos in commerce became rapid.

The method of mining was at first crude quarrying and hand picking, the best material only being selected. A great deal of short fiber remained in the waste rock of the dump. With the increasing demand came competition, for Russia and Italy soon entered the list of producers. To meet the requirements of economy it became necessary to devise special machinery which would increase the output, reduce the expense of labor, and effect a better saving of values in lower grades and by-products.

There has been an extended investigation, and great ingenuity has been shown in developing the machinery of the large modern mills, of which there are now nearly a score in connection with the asbestos mines of Canada.

Breaking the rock and picking out the fibrous pieces (Nos. 1 and 2 crude, according to length) is generally called "cobbing," and should be considered a part of the mining process before the rock goes to the mill. The mills differ widely in their machinery, each being suited to the special conditions it has to meet; but the majority of them contain one or more forms of rock breakers for the preliminary crushing of the rock. For the final crushing rolls and fiberizers are used, and of the latter the "Cyclone," now so generally employed, must be considered one of the chief appliances in separating the asbestos and preparing it for the pneumatic processes, of which the screens, fans, and settling chambers are important parts. It should be noted, however, that in one of the large mills recently erected at Black Lake, Canada, the Cyclone pulverizer is entirely replaced by a series of coarse and fine rolls. Several other plants in Canada have heretofore attempted to discontinue the use of the Cyclone, but most of them have taken it up again.[a] In some mills the tailings are ground to fine powder in pulverizers.

The development of the asbestos industry, as far as mining and milling are concerned, is wholly Canadian, but when we consider the manufactured products the United States is in advance of all other countries.

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[a] Cirkel, Fritz, Canadian Min. Jour., February 15, 1908, p. 11.

The relatively great importance of the industry to the United States results directly from the fact that a number of the largest Canadian mines are owned in the United States and that several of the owners have factories in this country. The Keasbey & Mattison Company, owning the Bell Asbestos Company mines at Thetford, Canada, has several large factories at Ambler, Pa. The H. W. Johns-Manville Company, whose mines are near Danville, Canada, has large factories at Brooklyn, N. Y., Milwaukee, and West Milwaukee, in Wisconsin. The mine which up to the present time is reported to have produced more asbestos than any other is the King Brothers mine at Thetford, controlled by a company of which R. H. Martin, of New York, is president. The Beaver Asbestos Company, with mine near Thetford, is under the same management. But these companies, the Dominion Asbestos Company, the Manhattan Asbestos Company, and several other companies, all of which are said to be controlled by American capital, are not known to be manufacturers in the United States, though the bulk of the raw material from most of their mines comes to this country.

Raw asbestos is imported free into the United States, while there is a duty of 25 per cent on imported manufactured asbestos. In Canada all the larger mines are reported as paying an annual license of $500.

## USES.

The fundamental property of asbestos, upon which its use depends, is its flexible, fibrous structure, but coupled with this are the scarcely less important qualities of incombustibility and slow conduction of heat and electricity when the mass is fiberized and porous, which make it valuable not only for fireproofing, but for insulating against heat and electricity.

It was first used only for spinning and weaving, to make incombustible thread, yarn, rope, and cloth, and this use has continued to be the most important application ever since the days of the Greeks and Romans. Only the highest grades of asbestos—Nos. 1 and 2 crude, with best grade from the mills—can be used for this purpose. Thread can now be spun so fine that it will run about 32,000 feet to the pound. The cloth is extensively employed for making theater curtains and for other fireproof and insulating uses.

Asbestos has been widely used of late in the electrical arts as a basis of insulation which must withstand somewhat elevated temperatures, and also as a fibrous binder for a great number of insulating compositions. It has a fiber, practically the only one, which is of a refractory nature, and is at the same time an electrical insulator of high order. Further, asbestos is not affected chemically by many of the active chemical agents likely to attack most insulations. It is extensively used for boiler and pipe coverings, to prevent heat radiation, and its efficiency is greatly increased by developing the cellular structure of the covering. It may be rendered more efficient, too, by a composition in which the asbestos acts as a binder for some good nonconductor. There are many patents concerning mixtures of asbestos with various compounds to produce incombustible and insulating pastes and moldable or solid material suited to many different purposes. They play an important part in many fireproof constructions where electricity and heat are used. Such materials are asbestos building lumber, century shingles, asbestos wood, asbestos slate, asbestic for stucco and plaster, and asbestolith.

A mass of asbestos broken into fibers and then again compressed is highly porous; but it may be rendered not only waterproof, but an especially effective insulator under conditions of varying moisture, by being saturated with certain varieties of asphalt.

As a nonconductor of heat it is used not only in the preparation of fireproof safes and vaults, but also for cold-storage and cooling structures. Houses made of asbestos materials or coated with asbestos throughout are not only warmer in winter, but cooler in summer.

## PRODUCTION AND IMPORTS.

The United States in 1906 produced 1,695 tons of asbestos, but in 1907 the production decreased to 653 short tons, a decline of over 61 per cent. The value of the asbestos (in part estimated) in 1907 was $11,899.

Nearly all of this output came from the Sall Mountain and Hollywood mines in Georgia, which is the only State that furnished asbestos for the market in 1907, and nearly half of the quantity produced was exported. The asbestos mined in Georgia is all of the amphibole variety. In the following table are given the quantity and value of the asbestos produced in the United States annually since 1890. With these are given the value of the imported asbestos, both unmanufactured and manufactured:

*Annual production and annual value of imports of asbestos into the United States, 1890–1907.*

| Year. | Production. | | Imports. | | |
|---|---|---|---|---|---|
| | Quantity (short tons). | Value. | Unmanufactured. | Manufactured. | Total. |
| 1890 | 71 | $4,560 | $252,557 | $5,342 | $257,899 |
| 1891 | 66 | 3,960 | 353,589 | 4,872 | 358,461 |
| 1892 | 104 | 6,416 | 262,433 | 7,209 | 269,642 |
| 1893 | 50 | 2,500 | 175,602 | 9,403 | 185,005 |
| 1894 | 325 | 4,463 | 240,029 | 15,989 | 256,018 |
| 1895 | 795 | 13,525 | 225,147 | 19,731 | 244,878 |
| 1896 | 504 | 6,100 | 229,084 | 5,773 | 234,857 |
| 1897 | 580 | 6,450 | 263,640 | 4,624 | 268,264 |
| 1898 | 605 | 10,300 | 287,636 | 12,897 | 300,533 |
| 1899 | 681 | 11,740 | 303,119 | 8,949 | 312,068 |
| 1900 | 1,054 | 16,310 | 331,796 | 24,155 | 355,951 |
| 1901 | 747 | 13,498 | 667,087 | 24,741 | 691,828 |
| 1902 | 1,005 | 16,200 | 729,421 | 33,011 | 762,432 |
| 1903 | 887 | 16,760 | 657,269 | 32,058 | 689,327 |
| 1904 | 1,480 | 25,740 | 700,572 | 51,290 | 751,862 |
| 1905 | 3,109 | 42,975 | 776,362 | 70,117 | 846,479 |
| 1906 | 1,695 | 28,565 | 1,010,454 | 65,716 | 1,076,170 |
| 1907 | 653 | 11,899 | 1,104,100 | 200,371 | 1,316,379 |

The production in the United States is now only about 1 per cent of that of Canada, and its insignificance becomes more pronounced when the grade of the material is considered. The asbestos mined in the United States is almost wholly of the amphibole type and can not be used for spinning and weaving like the high-grade chrysotile of Canada.

Of the imported unmanufactured asbestos practically all comes from Canada. As to the manufactured asbestos, however, the reverse is true; only a small quantity comes from Canada, and of the rest, over 75 per cent comes from the United Kingdom.

### CANADIAN PRODUCTION.

*Production of asbestos in Canada, 1896–1907.*

| Year. | Short tons. |
|---|---|
| 1896 | 10, 891 |
| 1897 | 13, 202 |
| 1898 | 16, 123 |
| 1899 | 17, 789 |
| 1900 | 21, 620 |
| 1901 | 32, 891 |
| 1902 | 30, 219 |
| 1903 | 31, 129 |
| 1904 | 35, 635 |
| 1905 | 50, 670 |
| 1906 | 59, 283 |
| 1907 | 62, 018 |

In this table is given the annual production of Canada since 1896. Except a slight falling off in 1902 and 1903 the increase in the production has been rapid and still continues. In 1907 it reached a total of 62,018 short tons, valued at $2,482,984, besides 28,519 short tons of asbestic, having a value of $22,059. During the fiscal year ending June 30, 1907,[a] there were 45,544 tons of unmanufactured asbestos imported from Canada into the United States. This would seem to show that approximately 73 per cent (valued at about $1,812,578) of the total production of Canada in 1907 came to the United States. During the same period the total importations of asbestos from Germany, Italy, and the United Kingdom—the only other countries from which asbestos was obtained—aggregated only $1,646 in value. More than a year ago it was estimated that Canada produced 85 per cent of the world's supply of asbestos. In 1907, owing to the large increase in the production of Canada, that country doubtless contributed a still larger percentage of the total yield of the world, and its controlling position in the asbestos industry is apparent.

Twelve companies are reported as producing asbestos in Canada in 1907, and four new ones are making extensive preparations for production in 1908, so that a much larger yield may be expected for 1908.

### PRICES AND CONDITIONS OF TRADE.

In the amphibole asbestos trade in the United States there was a decline of about 10 per cent in 1907, though the price ranged about $18 per ton, a figure somewhat higher than that for 1906.

The demand for the best grades of chrysotile asbestos has kept ahead of the supply. Some of the manufacturers report that the best grades can not be bought in the open market, and that the high prices have a tendency to restrain the progress of the industry. The range of prices for the various grades reported by a number of firms is as follows:

| | | |
|---|---|---|
| No. 1 crude asbestos | per ton | $275–$350 |
| No. 2 crude asbestos | do | 150– 200 |
| Asbestos fiber (according to grading) | do | 25– 150 |
| Fines (according to grading) | do | 10– 25 |

The special features of interest regarding the industry in Canada during 1907 are said to have been increased output, higher prices, and further consolidation of mining interests.[b]

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[a] Bureau of Statistics, Department of Commerce and Labor.
[b] McLeisch, John, Mining World, March 14, 1908, p. 445.

## NOTES ON THE ASBESTOS DEPOSITS OF THE UNITED STATES.

### GENERAL STATEMENT.

It is a matter of deep regret that the United States is unable to supply from its own mineral resources the great and increasing demand for asbestos. Prospectors aware of its value are looking for asbestos at many places; and since it is the primary object of this publication to consider production, it should note not only the mines now producing, but also the active prospecting in regions where asbestos is known to occur, in anticipation of possible future production. The best asbestos is chrysotile, and it forms cross-fiber veins in serpentine. The serpentine inclosing the veins may contain much short fiber. All serpentine areas should therefore be prospected for asbestos. The most promising masses are those associated with other old crystalline rocks which have been subjected to a succession of crushing stresses during several mountain-building epochs.

Owing to the great variation in the rocks, it is difficult to give definite data for determining a workable property, but a most important feature is the abundance of cross-fiber veins from which the crude fiber may be obtained. That is not essential, however, for in a number of Canadian mines no crude is produced, but the milling rock is rich in short fiber.

According to F. Cirkel,[a] in a few mines working rich ground the quantity of Nos. 1 and 2 crude can be put down as from 1 to 2 per cent of the total rock mined. An average of the milling rock furnished by the mines may be taken as from 30 to 60 per cent of all rock mined, with a minimum of 20 per cent and a maximum of 70 per cent; and of the rock milled, from 6 to 10 per cent is extracted as fiber. These percentages afford an approximate basis for judging of prospects, but apply only to serpentine.

Prospecting amphibole asbestos, especially of the slip-fiber and cross-fiber types, is not encouraging. They may be regarded perhaps as unpromising features, for the most successfully mined amphibole asbestos is the mass-fiber type, where slip and cross fiber are practically absent. In the southern Appalachians intruded masses of pyroxenite, altered to mass fiber, may be much more common than now supposed. They are frequently so weathered as to afford no solid outcrop, but generally contribute asbestos fiber to the soil, and may thus be discovered.

### DEPOSITS BY STATES.

#### GEORGIA.

*Sall Mountain.*—The asbestos production of the United States has never been large, and the principal part of it for over a dozen years has come from the Sall Mountain mine, in Georgia. Operations began at this point about 1894. A mill was built, including, with numerous accessories, two Raymond pulverizers. The mill has a capacity of about 10 tons a day. Two grades of material are produced, depending upon the quality of the material furnished the mill.

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[a] Asbestos, its occurrence, exploitation, and uses, p. 78.

The asbestos mined at Sall Mountain is mass fiber. It is of an entirely different type from the most part of that mined elsewhere in the United States or Canada. The rock is amphibolite; its whole mass is made up of groups or bundles of more or less radial, fibrous asbestos, which ranges in length from 1¼ inches down to a small fraction of an inch. These radial fibers tend to form spherical bunches, but with interferent crystallization these bodies are only imperfectly developed, and in most cases the radial structure is lost in an irregular accumulation of fibrous sheaves or bunches running in all directions and giving the rock an aspect of coarse granular crystallization. None of the fibrous amphibolite masses are schistose, though near the edge they sometimes pass into talc schist with definite fissile structure.

The fibrous amphibolite, composed of anthophyllite[a] where best developed and freshest in the Sall Mountain mines, is grayish white, and composed so largely of asbestos fiber that, according to the estimate of the superintendent, Mr. S. B. Logan, considerably over 90 per cent of the original rock is realized as fiber. Besides a little talc and carbonate of lime, the best rock contains numerous small grains of pyrite and magnetite, which upon alteration stain the fiber brown with iron oxide, and in the course of time the whole mass softens without losing its fibrous structure. The tensile strength of the fiber is reduced in this change, but sufficient strength still remains to make the fiber useful as a binder when mixed with other material. The occurrence and persistence of these masses of fibrous amphibolite is a matter of prime importance, and the mines at Sall Mountain throw considerable light upon the subject. Within an area a little more than an eighth of a mile square there are six separate masses, each one roughly elliptical in shape. Three of these, embracing the most important, are in line, with their longer axes approximately parallel and running N. 80° E. They are all embedded in gneiss, which is well exposed at many points in the mine and in places appears to be cut by the amphibolite as an eruptive.

The largest mass of amphibolite (the original discovery) had a length of about 75 feet and a width, near the middle, of 50 feet. It is nearly mined out at a depth of 50 feet, and unless the small remnant at the southwest corner shows connection downward, as seems improbable from the course of the walls exposed, the mass is completely cut off below by the gneiss. The two smallest masses have been completely removed, showing a continuous exposure of the decomposed gneissoid rocks beneath. The relations of the three remaining amphibolite bodies to the gneiss have not been fully determined. The quality of the remaining bodies is inferior to that of the largest body, but they will supply the mill for some years to come.

*Cleveland and Soque.*—Near Cleveland, 5 miles southwest of Sall Mountain, there is a group of comparatively small undeveloped masses of fibrous amphibolite, like that of Sall Mountain. These are in a belt, trending about N. 41° E. almost directly toward the Sall Mountain locality. They are surrounded by gneiss. The Sall Mountain Company owns this property and hauls the material to the Sall Mountain mill.

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[a] A brief account, including chemical analyses, of the asbestos of Sall Mountain and other localities in Georgia, was published by G. P. Merrill in the Proceedings of the U. S. National Museum, vol. 18, 1895, pp. 282–291.

Near Soque, 7 miles northeast of Sall Mountain, are several small areas of exposed amphibolite with short fiber. The amphibolite is here associated in the same ledge with a fresh rock that is composed chiefly of a mineral which appears to be pyroxene or olivine, with numerous acicular crystals and fibrous bundles of orthorhombic amphibolite, probably anthophyllite. The rocks, like those of Bedford and Rocky Mount, Va., and unlike those of Sall Mountain and Cleveland, Ga., have been sheared and locally, on the planes of shearing, contain considerable slip fiber, which attracted the attention of the prospectors. The strike of the amphibolite belt, as well as the plane of shearing, is approximately N. 70° W. Several other localities of the same material occur farther northeast, in Habersham and Rabun counties. One of them, the Miller property, was worked many years ago; but as far as known they are not of economic importance.

*Hollywood mine.*—A small production of asbestos, in 1907, is reported, by the National Asbestos Company, from a mine near Hollywood, in Habersham County, Ga., where a new mill was operated for a few months and then closed. The rock is firm and comparatively fresh. The least-altered portion is composed of coarse granular pyroxene and acicular fibrous amphibolite (asbestos), with much talc, chlorite, and magnetite.

### VIRGINIA.

*Bedford County.*—Virginia has been reported as a producer of asbestos for a number of years, but it did not produce any in 1907. The mines, now inactive, are located in Bedford and Franklin counties, and the mill at Bedford City for fiberizing the material is closed.

The Bedford asbestos mines are on the Hubbard farms, 12 miles south of Bedford City, and are spread over two areas, one of about 2 acres and the other of 5 acres.

The asbestos rock is of two types. One type, like that of Sall Mountain, Georgia, is composed essentially of fibrous amphibole, and the other is a peridotite composed chiefly of a granular mineral which appears to be olivine, with numerous acicular crystals and fibrous bundles of anthophyllite.

In the amphibolite the fibers are arranged in groups or bundles lying in all directions—mass fiber similar to that of the Sall Mountain mines in Georgia. Only a small mass of it occurs in the Bedford region. In the northern part of the area, northeast of Mrs. Hubbard's house, a vertical dike-like mass of it 5 feet in width, with a strike N. 80° W. lies parallel to the schistosity between masses of pyroxene-hornblende schist. It seems most probable that the amphibolite, composed of mass-fiber asbestos, at Bedford, Va., and Sall Mountain, Georgia, is derived from pyroxenite, but the evidence favoring this view can not be considered in this paper.

The peridotite type of asbestos rock is cut by a few small veins of cross-fiber anthophyllite from one-eighth to three-fourths of an inch in length. The fiber is flexible and somewhat elastic, but it has numerous cross fractures, and unlike chrysotile, it is relatively short and brittle.

This rock is cut also by occasional planes of shearing, along which there have been developed veinlike masses of slip fiber, which lie parallel to the plane of slipping. These are the masses that attract the attention of the prospectors, and are the parts that have been mined out. They are locally 18 inches in thickness, and have a length along the strike of about 30 feet. How far they have been followed in depth could not be learned, as the holes were filled with water at the time of the writer's visit. These masses of slip fiber are very irregular, and, as far as yet known, of so small extent as to furnish a very unreliable basis of mining operations.

*Franklin County.*—A small quantity (40 tons) of slip fiber has been mined near Rocky Mount in Franklin County. The vein, with strike S. 50° E. and steep dip to the northeast, lies parallel to the schistose structure of the inclosing amphibolite. It has been mined out in a shaft nearly 40 feet in depth. The amphibolite is much altered. Its principal constituent is acicular crystals and fibrous bunches of a colorless mineral with cleavage like amphibole. It looks very like anthophyllite, but has inclined extinction and is probably tremolite.

All of the asbestos-bearing rocks of the Rocky Mount region are practically amphibolite. Locally it contains some olivine and is much altered to chlorite and serpentine. In none of the outcrops prospected does the amphibolite contain a sufficiently large percentage of asbestos to indicate clearly the probability of profitable mining.

There are two belts of amphibolite lying between masses of mica schist, which has remarkably regular cleavage, so that it can be split into thin slabs yards in extent and has been quarried for curbing and flagging. The schistose structure is not nearly so prominent in the amphibolite as in the neighboring mica schist.

### VERMONT.

The formations which in Canada contain valuable deposits of asbestos extend southwest into Vermont, where similar masses of serpentine with considerable asbestos are known to occur. They were thoroughly prospected some years ago, and regarded as sufficiently encouraging to warrant the erection on the southeastern slope of Mount Belvidere of a large mill for the extraction of fiber, but the attempt was unsuccessful.

Another endeavor is now in progress by the Lowell Lumber and Asbestos Company. A mill was erected in 1907 on what was formerly known as the Tucker property, which contains a type of separating machinery different from that of the Canadian mills. Although not completed in time to produce any marketable fiber in 1907, it began operations early in 1908, and when seen in operation, May 5, 1908, a carload of fiber had already been shipped for the manufacture of paper.

### TEXAS.

At Dallas, Tex., a small percentage of asbestos mixed with other ingredients is used to make asbestos paint. The asbestos is a dull-greenish amphibole, possibly actinolite, for it has inclined extinction. It is said to be obtained in Texas and appears to be used only in the manufacture of asbestos paint.

### WYOMING.

Active prospecting continues in the Casper region, Wyoming. Many claims have been taken up and consolidated under a few companies, but as yet there is no regular production nor are there any mills in the course of erection. Some of the hand-cobbed material has been fiberized and used successfully in Denver for manufacturing pipe covering.

There are two districts of asbestos-bearing rocks in the Casper region—one on Casper Mountain, 9 miles directly south of Casper, embracing approximately an area equal to three sections, and the other half as large, on Smith Creek, 30 miles southeast of Casper.

In both districts the asbestos occurs in serpentine almost wholly in the form of cross-fiber veins. It is chiefly chrysotile, but the fact that some of it has a considerable degree of brittleness suggests that it may be amphibole. This is true especially of the small quantity of slip fiber which occurs sporadically in the serpentine. The veins of asbestos rarely attain 2 inches in thickness. The larger ones are generally jointed or banded parallel to the vein walls, thus parting the fiber into shorter lengths. The most common type of asbestos-bearing rock is banded by numerous minute parallel veins of asbestos, which range from a mere fiber to one-fourth inch, rarely one-half inch, in thickness. These cross-fiber veins are so abundant in places that they form from 20 to 50 per cent of the banded rock. The belts of banded rock range from a foot to several feet in thickness.

Much of the serpentine is covered by soil. Weathering is deep and impairs the asbestos near the surface. The best exposures of fiber are in some of the deeper shafts. This does not mean that the quantity of asbestos increases with the depth, but to some extent the quality may improve.

The highest grades, Nos. 1 and 2 crude, are practically absent from most of the area already prospected, but there are locally considerable masses of rock suitable for milling. They constitute, however, a small percentage of the whole body of the serpentine.

The serpentine is cut by the granite of the same region, and although the intrusion of the granite may be regarded as resulting in the formation of much of the asbestos, yet it must not be forgotten that the granite limits the serpentine.

### ARIZONA.

The Grand Canyon asbestos deposits of Arizona have been described in part by Dr. J. H. Pratt in Mineral Resources for 1904, where he gives an account of the deposits near the bottom of the canyon, about 20 miles east of Grand Canyon station on the Santa Fe Railway.

Within the last few years similar deposits have been found on the north side of the canyon, 25 miles northwest of Grand Canyon station, in the vicinity of Bass Ferry. The Grand Canyon at this point is 4,500 feet deep, and the asbestos occurs about 450 feet above the bottom. When the river is low, it is crossed in a rowboat, but when it is high by means of a suspended car. The most direct line of trail, when completed, will be about 8 miles long, and transportation up to the rim is effected by means of burros, each animal carrying about 90 pounds.

The Grand Canyon exposes an excellent section of the Carboniferous, Cambrian, Algonkian, and Archean rocks. The Algonkian is markedly unconformable with the overlying Cambrian as well as the underlying Archean, and forms a wedge-shaped mass with its edge along the canyon near its bottom and thickening rapidly to the north. The asbestos occurs in the basal portion of the Algonkian. This is made up, first, of a few feet of siliceous conglomerate overlain by about 50 feet of variously colored fine shaly beds, locally calcareous or serpentinous. Then follows 15 feet of whitish limestone containing layers and nodules of serpentine with more or less asbestos. Above the asbestos limestone comes a heavy layer of compact diabase about 200 feet thick, and above the diabase is a bed of limestone and shaly rocks similar to those immediately below the diabase. A little asbestos may be seen in the limestone above the diabase, but it is much more abundant in the lower limestone.

The asbestos-bearing limestone below the diabase varies considerably from place to place, but for the most part has approximately the following section:

*Section of asbestos-bearing limestone in Grand Canyon, Arizona.*

| | Feet. |
|---|---|
| Compact limestone | 1.8 |
| Serpentine with veins of asbestos | 1.2 |
| Banded whitish limestone | 12.0 |

The upper and lower portions of the limestone may contain some bands and nodules of serpentine, but they are not as persistent as the intermediate layer of serpentine, in which is found nearly all the asbestos. It occurs in cross-fiber veins which lie parallel to the bedding in the limestone.

The cross-fiber veins range from a small fraction of an inch to about 3 inches in width, and are remarkable for their golden-yellow color as well as for the tensile strength of the fiber.

The overlying diabase looks unaltered, and at its contact with the limestone is distinct, except where the top of the limestone is serpentine.

The facts observed in the field appear to indicate that the serpentine which includes the asbestos (chrysotile) is derived from some mineral in the limestone and not from the diabase. Conclusive evidence concerning its derivation can not be obtained until the rocks are examined in the laboratory. If the suggested conclusion proves to be true, the Grand Canyon asbestos affords a type quite different in origin from any yet found at other localities in the United States.

Four asbestos claims have been taken, one on the upper and three on the lower limestone, along which the thin belt of included asbestos-bearing serpentine has been prospected in a number of shallow open cuts for over half a mile. The continuity of the narrow asbestos belt is very irregular, and disappears locally; but it is abundant enough in places to suggest the probability that Nos. 1 and 2 crude fiber carefully selected from the veins may be mined to a small extent at a profit. It does not seem at all probable, however, considering the limited quantity, location, and distribution of the deposit, that it would pay to mill.

### CALIFORNIA.

Prospecting continues in the large mass of serpentine cut by the canyon of American River, 2 miles east of Towle, on the Southern Pacific Railroad in Placer County, Cal. The canyon is more than 1,000 feet deep and affords excellent exposures. Several tunnels have been run into the steep slope to the depth of 100 feet or more. Small veins of short cross fiber and irregular sheets of strong flexible slip fiber have been discovered, but they are too sparsely distributed to be mined with profit for the fiber alone.

### THE PHILIPPINES.

In the Philippine Journal of Science, also in the Far Eastern Review for June, 1907, Mr. Warren D. Smith gives an account of prospects of asbestos in Ilocos Norte, in the northern part of the island of Luzon. There has been no production, nor, indeed, much definite prospecting. It is certain, however, that there is a large mass of pyroxenite and serpentine in that region, and it contains locally some asbestos, part of which is fibrous serpentine, but most of it is of the amphibole type. It appears that the asbestos is sufficiently abundant to justify thorough prospecting with a view to determining its workability.

# ASPHALT AND BITUMINOUS ROCK.

By JOSEPH A. TAFF.

## INTRODUCTION.

The term asphalt is commonly used to denote the various forms of bitumen in the natural and refined states. The natural semiliquid or viscous bitumen is called maltha, mineral tar, or brea. A similar and often more liquid form extracted from bituminous rock is termed mastic. A closely related bitumen is recovered as a by-product in the distillation of certain crude asphaltic petroleums, and is known in the trade as oil asphalt. Of the oil asphalts there are several grades, termed "A," "B," "C," etc., according to state of refinement, grade "A" being the highest. In addition to these uses, the term asphalt is employed broadly to include a series of solid hydrocarbons or asphaltites known as gilsonite, elaterite, grahamite, "tabbyite," and other related hard asphaltic substances. Ozokerite, a mineral wax, is a natural paraffin, and has been classed statistically with asphalts.

It appears that there are gradations between the various species of both viscous and solid asphalts, depending upon the composition and relative quantities of the more volatile constituents. At one end of the series the percentage of volatile oil is so large that the asphalt is essentially fluid, while at the other the volatile matter is so small that the mineral is not convertible by the use of solvents into a commercial product. Such is the state of a species of grahamite found in eastern Oklahoma.

The term bituminous rock is used to designate all kinds of rock, whether in the friable or solid state, that contain an appreciable quantity of bitumen or asphalt intermingled with their particles. Bituminous rock therefore includes asphaltic earth, sand, sandstone, shale, limestone, etc.

## OCCURRENCE.[a]

The asphaltic hydrocarbons occur naturally in three principal forms, (1) in the viscous, semiliquid state, filling interstices and cavities in rocks of almost every class, but most abundantly in sand as asphaltic sand and in sandstone and limestone strata because of their great porosity; (2) as viscous and semiliquid tenacious exudations from the earth, either directly from the exposed bituminous rock or from subterranean passages; (3) as solids in the form of veins or cavities cutting across or extending between beds of rock. The asphalts are found in commercial quantity in or associated with sedimentary rocks of almost all kinds and of all ages, from the Ordovician to the Pleistocene. They are found in smaller quantity impregnating certain schists and occasionally in igneous rocks.

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[a] For more complete information as to asphalt deposits see Asphalt and bituminous rock deposits of the United States: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 1, 1901, pp. 219–452.

*Bituminous rock.*—Extensive deposits of asphaltic shale and sandstone are found in California in and contiguous to the oil fields from the vicinity of Santa Cruz southeastward, generally parallel with the coast line. The bitumen permeates porous sandy strata, and exudes at the surface from highly bituminous oil-bearing deposits. The asphalt in this region appears for the most part to be a residue by natural distillation at or near the surface of the earth from the same crude oil that yields the oil asphalt.

Utah contains large deposits of both asphaltic limestone and sandstone. Those probably of greatest purity and highest quality are the asphaltic limestones in the vicinity of Indian and Lake canyons in Strawberry Creek valley, Wasatch County; on Tie Fork of Soldier Creek, northwest of Tucker Station, on the Rio Grande Western Railroad, Utah County; and between Soldier and Diamond creeks, a few miles northeast of Thistle Junction, in the same county. Similar deposits of bituminous limestone are known near the head of Whittemore Canyon, north of Sunnyside, in Carbon County. In Strawberry Creek valley, especially, the bituminous rock seems to be associated with veins of elaterite, and it is probable that the asphalt contained in the limestone partakes of the nature of elaterite or gilsonite. The brea or natural gum that exudes from the bituminous rock at certain localities in Wasatch and Carbon counties is notably tenacious and appreciably elastic. Bituminous sandstone is reported in Uinta County, east and northwest of Jensen, and in the Book Cliffs, toward the sources of Willow and Whittemore creeks, in Carbon County. These bituminous rock deposits are flat-lying, and are usually accessible from the sides of the canyons and valleys. All of the bituminous rock deposits of Utah at present known are contained in formations of Tertiary age and occur in or near the boundaries of the Uinta Basin.

Extensive deposits of bituminous rock are found in Oklahoma. Flat-lying strata of bituminous sand occur in eastern Stephens, in Jefferson, and in western Carter counties in supposed Permian strata. Notable deposits occur near Loco and Asphaltum. Asphaltic sandstones, more or less steeply inclined, are found in Carboniferous rocks near Woodford, Ardmore, Buckhorn, and Fitzhugh. Bituminous sandstone and limestone in large quantity and of considerable richness are found at Gilsonite and near Sulphur and Dougherty, in Murray County, in rocks of Ordovician age.

Bituminous rock is found in Texas as an asphaltic sand and limestone occurring in the basal Cretaceous rocks in Burnet and Montague counties, as asphaltic limestone of upper Cretaceous age in Nueces County, and as the asphaltic limestone of Uvalde County, which appears to be of greater importance at the present time than the bituminous sandstone. This limestone is very porous, the interstices and cavities containing a semiliquid asphalt equal to about 15 per cent of the whole rock.

The asphalts of Kentucky occur as bituminous impregnations of flat Carboniferous sandstones, chiefly in the western part of the State, and principally in Breckenridge, Grayson, Edmonson, Warren, and Logan counties.

Asphaltic sandstone of probable commercial value is found in southwestern Wyoming, sec. 15, T. 15 N., R. 118 W. The bed is 6 feet thick, and its areal extent is not known. Another asphaltic sandstone of similar quality and of the same thickness occurs in the Bighorn Basin, northern Wyoming, secs. 28, 29, 32, and 33, T. 52 N., R. 89 W.

Asphaltic sands of Cretaceous age occur in the lower Cretaceous near Wolf Creek, Pike County, Ark. Bituminous sandstone of Carboniferous age has been developed commercially in the vicinity of Higginsville, Lafayette County, Mo., and bituminous rock has been reported from Fulton County, Ga. Presumably for trade reasons bituminous rock deposits are not exploited at the present time in these three States.

*Brea.*—Brea, the natural plastic asphalt, has not been found in the United States in sufficient quantity to warrant profitable exploitation. It is widely distributed in the California oil fields, where it is formed at the surface of the earth by evaporation of the lighter oils from seepage of crude petroleum. In Oklahoma it exudes at many places from bituminous-rock deposits, but in smaller quantities.

*Oil asphalt.*—Certain crude petroleums of the California and Texas coast regions and in the Kansas and Oklahoma oil fields contain quantities of asphalt in solution. Some of these crude oils are said to contain over 35 per cent of oil asphalt, the asphalt being so abundant as to be an essential commodity in their commercial treatment.

*Gilsonite.*—Gilsonite is the most abundant of all the known hard asphalt substances in the United States. It is found in northeastern Utah, in Uinta and Wasatch counties, where it occurs in vertical gash veins or fissures, cutting across nearly flat Tertiary rocks. The veins of gilsonite bear in general northwest-southeast directions, and vary in width from thin stringers to several feet. At one locality a vein 18 feet thick has been reported. The same vein extends for several miles with thicknesses varying from 4 to 12 feet. The horizontal length of some of these veins is known to be many miles, but their vertical depth as a rule is unknown. The best known of the thicker deposits of gilsonite in Utah are in the central part of the Uinta Basin, on both sides of White River valley. Notable localities are near Dragon and on the north side of White River near the Colorado State line. Other important deposits are at Pariette, near Fort Duchesne, and northwest of Fort Duchesne.

Some of the gilsonite veins in Utah, in White River valley, extend into Colorado. Veins of similar species of asphalt occur in Willow Creek valley, near the north side of Middle Park, in Grand County Colo.

*Grahamite.*—A solid asphalt that is closely related to grahamite, and is known in the trade as grahamite, occurs at several localities in Oklahoma. One of these localities is in western Pushmataha and eastern Atoka counties northwest of Antlers, between the St. Louis and San Francisco and the Missouri, Kansas and Texas railroads. It occurs in vertical veins in highly folded sandstone and shale of Carboniferous age. The veins vary in width from stringers to bodies several feet thick. A solid asphalt of similar nature is found in Stephens County, Okla., near Loco, where it fills vertical fissures through flat-lying shale and sandstone of probable Carboniferous age. Similar but harder and more highly metamorphosed asphalt substances are found as fissure fillings in the district east of Page, in Le Flore County, Okla., and in western Arkansas. It is reported that these substances are too highly metamorphosed to be converted into products of commercial use. These grahamite deposits are characterized by perfect blackness, high luster, brittleness, and high grade of purity. One other locality for grahamite in the United States—the original locality—is in Ritchie County, W. Va., 25 miles east of Parkersburg, where it occurs filling a vertical fissure across Carboniferous strata, but the available supply has been exhausted. This was formerly known as "Ritchie mineral."

*Elaterite, "tabbyite," and ozokerite.*—Elaterite, "tabbyite," and ozokerite have been exploited commercially only in the western part of Uinta Basin, Utah. Elaterite, technically known as wurtzilite, is found in veins or fissures cutting across flat beds of limy shales in certain gulches tributary to Strawberry Creek valley in south-central Wasatch County. The elaterite veins are similar in form to those of gilsonite, but are more limited in vertical and horizontal range.

"Tabbyite," in the trade sense, appears to be a solid hydrocarbon that has elastic properties and is related probably to both gilsonite and ozokerite. It occurs in the same region and in the same class of rocks that bears the elaterite. It is expected that various gradations from the one to the other of the solid asphalts may be found in the Uinta basin region.

Ozokerite[a] is one of the rarest of the commercially valuable hydrocarbons, and it is at present the most valuable. It occurs in Utah in vertical fissures and zones of crushed rock cut in Tertiary strata near Midway, Soldiers Summit, and Colton Station, on the Rio Grande Western Railroad.

## USES.

Bituminous rock, a natural mixture of rock and included bitumen, usually consisting of sandstone or limestone, is used chiefly for paving. For this purpose it must be crushed and the bitumen or asphaltic content brought to the proper consistency and quantity with respect to the stone matrix. The mastic extracted from the bituminous rock in the presence of heat and moisture naturally carries a percentage of earthy impurities, as do the malthas and viscous asphalts that occur exuding from the surface of the earth. The natural asphalt imported from Trinidad and Venezuela supplies a large part of the eastern United States. The oil asphalt produced in various stages of refinement seems to meet all the requirements of an asphalt. In the refined state it is practically pure asphalt, being free from earthy substances commonly carried by the natural product; and although hampered in its use by freight haulage, large quantities are brought to the markets of the eastern United States and used for the various purposes to which an asphalt is applied. Mastic, natural asphalt, and oil asphalts are converted into similar commercial products and employed in the trades. The most extensive uses to which these products are applied are paving, road dressing, water-proofing for metals, papers, and fabrics, roofing, wood preservation, brick and wood block filling, concrete construction, reservoir and foundation linings, briquetting, and fluxing or converting solid asphalts. In the more refined states it is used for acid and fume proofing, insulations, etc.

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[a] For further information see ozokerite deposits in Utah, Bull. U. S. Geol. Survey No. 285, 1906, pp. 369-372.

Gilsonite, elaterite, and grahamite in converted and refined states fulfill all the uses to which the viscous asphalts are applied, besides having special adaptability for the manufacture of japans, paints, varnishes, electric insulations, marine cables, acid and fume proofing, and for coating high-grade metal surfaces. The chief advantages possessed by these substances are the perfectly smooth, solid, and more or less elastic coating they produce and the resistance they offer to the action of moisture and acids. It is probable that the refined products of certain mastics and of natural and oil asphalts have all the essential qualities of refined gilsonite and grahamite.

The natural ozokerite that occurs in Utah contains a small but variable percentage of bitumen, which gives it shades of dark brown to black and a hardness ranging between that of beeswax and that of a brittle solid having nearly the consistency of elaterite. It is used as a leather polish, in sealing wax, pencils, etc., and when refined it is a light yellow to white, and is manufactured into candles for special purposes. It may also be used as an insulator, and is said to make a good acid-proof coating.

## PRODUCTION.

The following table presents the output of all classes of natural asphalt, including bituminous rock that enter into the market from quarries and mines in the United States, together with refined asphalt that has been converted by producers of the crude material. The production in 1907 was 223,681 short tons, valued at $2,826,489, as against 138,059 short tons, valued at $1,290,340, in 1906, an increase of over 62 per cent in quantity and of over 100 per cent in value.

*Production of asphalt and bituminous rock, 1882–1907, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1882 | 3,000 | $10,500 | 1895 | 68,163 | $348,281 |
| 1883 | 3,000 | 10,500 | 1896 | 80,503 | 577,563 |
| 1884 | 3,000 | 10,500 | 1897 | 75,945 | 664,632 |
| 1885 | 3,000 | 10,500 | 1898 | 76,337 | 675,649 |
| 1886 | 3,500 | 14,000 | 1899 | 75,085 | 553,904 |
| 1887 | 4,000 | 16,000 | 1900 | 54,389 | 415,958 |
| 1888 | 50,450 | 187,500 | 1901 | 63,134 | 555,335 |
| 1889 | 51,735 | 171,537 | 1902 | 105,458 | 765,048 |
| 1890 | 40,841 | 190,416 | 1903 | 101,255 | 1,005,446 |
| 1891 | 45,054 | 242,264 | 1904 | 108,572 | 879,836 |
| 1892 | 87,680 | 445,375 | 1905 | 115,267 | 758,153 |
| 1893 | 47,779 | 372,232 | 1906 | 138,059 | 1,290,340 |
| 1894 | 60,570 | 353,400 | 1907 | 223,861 | 2,826,489 |

## PRODUCTION OF ASPHALT BY VARIETIES AND STATES.

The total production by varieties for four years is given in the following table, and the production in 1907 by States as well as by varieties is given in the succeeding table. Reports from producers for 1907 did not distinguish between bituminous sandstone and bituminous limestone. The localities from which the reports of production come induce the belief that almost the entire output of this class is a bituminous sandstone. The production from bituminous rock deposits in 1907 increased nearly 100 per cent over the production for 1906. There was a decrease in the bituminous rock output from 1904 to 1906, and a relative increase at the same time in the production of oil asphalt, nearly all of both products coming from California. It therefore appeared that the great increase in the production of oil asphalt was due to the decline in the production of bituminous rock, but this assumption does not seem to hold for the returns for oil asphalt production in 1907, which shows an increase of more than 100 per cent over that of 1906, with an increase in value of over 200 per cent. Kentucky stands second in the production of bituminous rock and is the only producer of mastic or extracted bitumen.

The output of gilsonite has also advanced nearly 100 per cent. The production of ozokerite was revived in 1907, and with it the related hydrocarbon "tabbyite." The production of these two substances being small and reported from single localities are combined in the table of production.

*Production of asphalt, 1904–1907, by varieties, in short tons.*

| Variety. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bituminous rock | 48,439 | $142,960 | 45,302 | $136,972 | 24,085 | $70,696 | 45,526 | $129,040 |
| Mastic | 1,200 | 10,800 | 2,200 | 22,000 | 2,543 | 24,158 | 1,744 | 16,568 |
| Gum | 6,637 | 141,446 | 3,036 | 41 438 | 24,178 | 341,106 | 5,195 | 78,400 |
| Maltha | 3,363 | 36,320 | 3,139 | 34,292 | 9,900 | 86,750 | 13,507 | 143,758 |
| Wurtzilite (elaterite) | 550 | 50,000 | 500 | 44,000 | 12,947 | 159,960 | 422 | 35,327 |
| Gilsonite | 2,978 | 14,175 | 10,916 | 47,040 | | | 20,285 | 531,965 |
| Grahamite | 1,000 | 25,000 | ........ | ........ | 1,952 | 16,432 | 966 | 7,743 |
| Ozokerite and tabbyite | ........ | ........ | 5 | 1,500 | ........ | ........ | 12 | 2,148 |
| Oil asphalt | 44,405 | 459,135 | 50,169 | 430,911 | 62,454 | 591,248 | 136,204 | 1,881,540 |
| Total | 108,572 | 879,836 | 115,267 | 758,153 | 138,059 | 1,290,340 | 223,861 | 2,826,489 |

*Production of asphalt in 1907, by varieties and by States, in short tons.*

| Variety. | California. | | Utah. | | Oklahoma. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bituminous rock | 34,531 | $84,016 | ........ | ........ | 4,002 | $11,627 |
| Gum | 5,000 | 75,000 | ........ | ........ | 45 | 900 |
| Maltha | 8,982 | 103,258 | ........ | ........ | 25 | 500 |
| Uintaite (gilsonite) | ........ | ........ | 20,285 | $531,965 | ........ | ........ |
| Wurtzilite (elaterite) | ........ | ........ | 422 | 35,327 | ........ | ........ |
| Ozokerite<br>"Tabbyite" | ........ | ........ | 12 | 2,148 | ........ | ........ |
| Grahamite | ........ | ........ | ........ | ........ | 966 | 7,743 |
| Oil asphalt | 82,555 | 951,683 | ........ | ........ | ........ | ........ |
| Total | 131,068 | 1,213,957 | 20,719 | 569,440 | 5,038 | 20,770 |

| Variety. | Kentucky. | | Texas. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Bituminous rock | 6,993 | $33,397 | ........ | ........ |
| Mastic | 1,744 | 16,568 | ........ | ........ |
| Gum | 150 | 2,500 | ........ | ........ |
| Maltha | 4,500 | 40,000 | ........ | ........ |
| Oil asphalt | ........ | ........ | 53,649 | $929,857 |
| Total | 13,387 | 92,465 | 53,649 | 929,857 |

## IMPORTS.

The following table shows the imports of asphalt by calendar years from 1903 to 1907, inclusive:

*Asphalt imported for consumption into the United States, 1903–1907, in short tons.*

| Year. | Crude. | | Dried or advanced. | | Bituminous limestone. | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 186,169 | $509,755 | 17,200 | $83,591 | 10,230 | $35,010 | 213,599 | $628,356 |
| 1904 | 117,184 | 490,809 | 16,766 | 100,081 | 6,496 | 20,236 | 140,446 | 611,126 |
| 1905 | 85,014 | 381,474 | 9,688 | 78,639 | 5,895 | 19,183 | 100,597 | 479,296 |
| 1906 | 100,818 | 355,493 | 14,178 | 114,076 | 5,086 | 15,110 | 120,082 | 484,679 |
| 1907 | 142,494 | 502,811 | 13,535 | 123,924 | 4,925 | 15,629 | 160,954 | [a] 645,464 |

[a] Imports for 1907 include $3,100 of manufactures.

More than one-half of the asphalt which is imported into the United States from foreign countries comes from the island of Trinidad, off the coast of Venezula. Other important sources of the material are Venezuela (Bermudez), Cuba, Italy, Germany, and Mexico. Smaller quantities are imported from Switzerland, France, the United Kingdom, and Turkey in Asia, with insignificant quantities from Colombia and Netherlands.

## EXPORTS.

During the fiscal year ending June 30, 1907, domestic asphalt and manufactures of asphaltic material to the total value of $379,476 were exported from the United States to other countries, as against similar exports valued at $299,091 in the fiscal year ending June 30, 1906.

### EXPORTS FROM TRINIDAD

The asphalt of Trinidad is described as occurring in two forms, land pitch and lake pitch, although there seems to be no fundamental difference between the two varieties. The pitch lake is the original source of all the asphalt which is exploited in the vicinity of the village of La Brea and between the village and the lake, the land pitch being material which has overflowed from the pitch lake through a crevice in its side and descended the slopes to the sea. The surface of the lake is 138 feet above the sea, its area is about 100 acres, and it is nearly circular in outline. Excavations in the lake pitch and in the land pitch also fill again with asphalt in a short time.

The exports of asphalt from the island of Trinidad increased somewhat during 1907 as compared with 1906. According to the report of the New Trinidad Lake Asphalt Company (Limited), through whose courtesy this statistical information regarding the asphalt of Trinidad has been received, the total quantity of asphalt exported from the island for the year ending January 31, 1908, was 161,126 short tons, as against 145,932 short tons in the year ending January 31, 1907, and 128,685 short tons in the year ending January 31, 1906. More than 2,840,498 short tons of asphalt have been removed from the pitch lake and exported to foreign countries since the records have been kept.

*Total exports of asphalt from Trinidad, 1906-7, in short tons.*

| Year. | To United States. | | | To Europe. | | | To other countries. | | | Grand total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lake. | Land. | Total. | Lake. | Land. | Total. | Lake. | Land. | Total. | |
| 1905 [a] | 53,701 | 13,581 | 67,282 | 54,640 | 577 | 55,217 | 5,900 | 286 | 6,186 | 128,685 |
| 1906 [b] | 71,902 | 5,292 | 77,194 | 68,284 | 454 | 68,738 | ........ | ........ | ........ | 145,932 |
| 1907 [c] | 97,243 | 4,642 | 101,885 | 58,787 | 224 | 59,011 | ........ | 230 | 230 | 161,126 |

[a] Year ending January 31, 1906. [b] Year ending January 31, 1907. [c] Year ending Janary 31, 1908.

# FULLER'S EARTH.

### Compiled by F. B. Van Horn.

## INTRODUCTION.

The term "fuller's earth" is used to include a variety of substances that possess strong absorbent properties. It was originally used for cleansing cloth of grease, and also for cleaning furs, but its main use in this country at the present time is for the clarifying of oils.

Dana defines fuller's earth as including many kinds of "unctuous clays, gray to dark green in color, and being in part kaolin and in part the mineral smectite." It is placed by him with several clay-like minerals (all of them hydrous silicates), namely, smectite and malthacite, of not very definite composition, but all having a high percentage of combined water. It is inferred that Dana considers these minerals the cause of the bleaching power of fuller's earth.

Ries defines fuller's earth as a clay-like substance that has the property of decolorizing or clarifying oils. He says: "An ultimate chemical analysis shows it to differ from most ordinary clays in having usually a high percentage of combined water and a low amount of alumina. There is probably a large amount of hydrous silica present. Fuller's earth possesses little or no plasticity, and in order to work properly has to be ground very fine. A chemical analysis is of little value at present in determining its quality; only a practical test suffices."

Geikie defines fuller's earth as "a greenish or brownish, earthy, soft, somewhat unctuous substance, with a shining streak, which does not become plastic with water, but crumbles down into mud. It is a hydrous aluminous silicate with some magnesia, iron oxide, and soda." According to Geikie, fuller's earth owes its detergent properties to physical characters rather than to chemical composition.

John T. Porter, in an article on the "Properties and tests of fuller's earth," presents a very interesting theory. He says that it is evident that Dana's theory will not stand since the discovery of American deposits having a comparatively low percentage of combined water. Such earths could not possibly have as their base either smectite or malthacite, although they might contain very small quantities of these minerals.

Concerning Ries's statement that fuller's earth probably contains much hydrous silica, inferring that it is this constituent which gives it its distinctive qualities, Porter says:

> My analyses have confirmed Ries's statement that fuller's earth contains appreciable amounts of hydrous silica. However, it is evident that if the bleaching power of fuller's earth is due to this hydrous silica, treatment of the earth with boiling carbo-

nate or hydrate of soda, which removes the silica, should destroy this bleaching power. I have tried this experiment on several earths, and although the results are not entirely concordant, yet there can be no doubt that fuller's earth retains at least a part of its efficiency after treatment by alkalies. It is also plain that carbonate of soda has a much less harmful action on the earth than the hydrate. As Fresenius and other authorities state that hydrous and amorphous silica are freely soluble in hot carbonate of soda, as well as in sodium hydrate, this difference can hardly be due to nonsolution of the silica by the carbonate, but is almost entirely due to partial decomposition of the earth by sodium hydrate. In this connection, I have noticed that sodium hydrate appears to extract considerable alumina as well as silica, but the carbonate does not. Fuller's earth after treatment with sodium hydrate is left in a very gelatinous condition and is extremely hard to filter and wash. For this reason it is possible that some of the samples treated retained considerable amounts of soluble salts after washing, although great pains were taken to remove them, and this may have had some influence on the results.

Another fact which might be used as an argument against this theory is that hydrous silica artificially prepared has but very slight bleaching powers. These results are naturally not conclusive, as the silicic acid occurring naturally may differ either physically or chemically, or both, from the artificial product.

On the other hand, some earths still retain a considerable portion of their bleaching power after decomposition by acids, consisting then of 80 per cent or more of silica; and from this it seems probable that hydrous silica when prepared in certain ways may have some small efficiency.

In conclusion, I think I am justified in stating, first, that hydrous silica does not of itself possess bleaching power, although it may at times possess some efficiency as a result of existing in a certain physical condition; and, second, that it is certain that fuller's earth can not owe more than a small part of its peculiar properties to the presence of free silicic acid.

Porter offers a new theory to explain the clarifying action of fuller's earth. It is based on the presence of a group of aluminum hydrosilicates existing in the form of pectoids. He says:

The theory which I have devised to explain the peculiar properties of fuller's earth may be stated as follows:

1. Fuller's earth has for its base a series of hydrous aluminum silicates.
2. These silicates differ in chemical composition.
3. They are, however, similar in that they all possess an amorphous colloidal structure.
4. The colloidal structure is of a rather persistent form and is not lost on drying at a temperature of 130° C., or possibly higher.
5. These colloidal silicates possess the power of absorbing and retaining organic coloring matter, thus bleaching oils and fats.

I have used the word colloidal in this statement in its broadest sense—to cover the whole range of conditions expressed by the words colloid, pectoid, and hydrogel. It is my opinion that the word pectoid would most properly express the condition of the active constituents of fuller's earth, but it is not impossible that these may go into partial solution in oil and thus become true colloids.

Colloids are known to possess the power of taking up organic colors from solution, and the analogy with fuller's earth is so apparent as to excite surprise that it has not been studied from this point of view before. It has even been known that pectoids could extract colors from oils and resins as well as aqueous solutions. This I regard as a strong point in favor of the colloidal theory, although by itself it does not, of course, constitute a proof.

The power of colloids to absorb certain salts, or at least the basic ions of these salts, has been known a long time. It is also possessed to a degree by certain amorphous substances having a fine porous structure, such as charcoal and boneblack. Fuller's earth has this property to a marked degree. In fact, its use has been proposed to remove the lime from boiler water. I have found that after it has absorbed ammonia or salts it loses a great part of its efficiency in bleaching oils. From this I infer that the bases are absorbed in a similar manner to the coloring matter of oil, and occupy the pores which otherwise would hold the color.

It has been pointed out that these absorbent materials have a selective action on the salts, absorbing the unlike ions and discarding the ions of like chemical nature. If colors in oil solution are absorbed in the same manner as salts in aqueous solution, analogy would lead to the supposition that fuller's earth would exert a selective action for certain classes of coloring matter and, moreover, that the earths themselves would differ in their selection of colors according as they are more or less acidic in composition. We find this entirely in accordance with the facts.

I have noticed in the course of my oil tests that on the same sample of oil different materials give products varying greatly in shade, the main color being in some tests of a yellow and in others of a green tint. Is it not likely that the oil contains several compounds of varying chemical nature, and that the earths or other materials used in bleaching extract them in ratios proportional to their own basicity or acidity? I have been unable to obtain any exact data on this point from my results, owing to the difficulty of following these slight changes in tint with the unaided eye. A tintometer would be needed if this line of investigation were to be followed out.

## MINING AND PREPARATION.

The fuller's earth in Florida is usually mined by pick and shovel, and hauled to the mill, where the earth is broken up into small lumps and put through rotary driers. It is then taken by elevator to the crushers and ground and bolted into several grades, 120 mesh being the finest. The material is then ready for shipment.

## PRODUCTION.

Fuller's earth was first discovered in the United States at Quincy, Fla., in 1893. The States producing it in 1907, in order of importance, were: Florida, Arkansas, Georgia, South Carolina, Massachusetts, Colorado, and Texas.

During the year 1907 the total production of fuller's earth in the United States was 32,851 short tons, valued at $291,773. This was an increase from the year 1906 of 811 tons in quantity and of $26,373 in value. Of the entire production in 1907, Florida furnished 22,960 tons, or 69.9 per cent.

The following table shows the production of fuller's earth in the United States since the beginning of production in 1895:

*Production of fuller's earth in the United States, 1895–1907, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1895 | 6,900 | $41,400 | 1903 | 20,693 | $190,277 |
| 1896 | 9,872 | 59,360 | 1904 | 29,480 | 168,500 |
| 1897 | 17,113 | 112,272 | 1905 | 25,178 | 214,497 |
| 1898 | 14,860 | 106,500 | 1906 | 32,040 | 265,400 |
| 1899 | 12,381 | 79,644 | 1907 | 32,851 | 291,773 |
| 1900 | 9,698 | 67,535 | | | |
| 1901 | 14,112 | 96,835 | Total | 236,670 | 1,792,137 |
| 1902 | 11,492 | 98,144 | | | |

## IMPORTS.

During 1907, there were imported 14,648 long tons of fuller's earth, valued at $122,221. The quantity and value of the imports into the United States since 1901 are shown in the following table:

*Fuller's earth imported into the United States, 1901–1907, in long tons.*

| Year. | Unwrought or unmanufactured. | | Wrought or manufactured. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1901 | 2,916 | $17,230 | 7,850 | $63,467 | 10,766 | $80,697 |
| 1902 | 3,785 | 26,635 | 9,728 | 75,945 | 13,513 | 102,580 |
| 1903 | 3,804 | 28,339 | 11,464 | 92,332 | 15,268 | 120,671 |
| 1904 | 1,763 | 95,416 | 7,363 | 64,460 | 9,126 | 74,006 |
| 1905 | 1,522 | 12,798 | 11,480 | 93,199 | 13,002 | 105,997 |
| 1906 | 2,594 | 20,129 | 10,643 | 88,566 | 13,237 | 108,695 |
| 1907 | 2,223 | 16,833 | 12,425 | 105,388 | 14,648 | 122,221 |
| Total | 18,607 | 131,510 | 70,953 | 583,357 | 89,560 | 714,867 |

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# GRAPHITE.

By **Frank L. Hess.**

## PRODUCTION.

Although most of the graphite producers of the United States reported a better demand for refined graphite during 1907 than in 1906, the output of flake graphite in the United States showed a considerable decrease, and the value of the total production was the smallest since 1903. Graphite was produced by seventeen companies in nine States and one Territory: Alabama, Alaska, Colorado, Georgia, Michigan, Nevada, New Jersey, New York, Pennsylvania, and Wisconsin. All is classed as amorphous, except that of New Jersey, New York, and Pennsylvania, which is termed flake graphite. The distinction is, however, to some extent due more to the conveniences of trade than to actual physical characteristics.

In general, the amorphous graphite is the more impure and is used for purposes where purity is not a prime requisite. Thus a graphitic schist mined in Georgia is ground and put into phosphates used for fertilizer, as a black color is demanded by consumers under the supposition that it means better quality. In Michigan graphitic rock is ground for use in paint. Such materials are of course cheaply prepared and are unfit for the better uses, such as in crucibles, lubricants, and electrical work.

During the year a small output was made by one company in Alaska. Considerable deposits exist 40 miles northwest of Nome, which appear to be much purer than most, if not all, of those worked in the United States. These deposits are not far from comparatively cheap transportation.

In New Jersey a graphite mine was started at High Bridge in a graphite-bearing gneiss. A tunnel was driven along the strike for a distance of about 400 feet.[a] About 3½ carloads of graphite, divided into four grades, were mined and shipped.

The production of crystalline graphite during the year was 4,947,840 pounds, valued at $171,149.

The amorphous graphite produced in the United States during 1907 amounted to 26,803 short tons, valued at $125,821.

American capital is invested in both Mexican and Canadian graphite mines, and large quantities of a very black, soft, amorphous graphite of high grade are imported from Mexico.

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[a] Kümmel, Henry B., Annual Report of the State Geologist for the year 1907: Geol. Survey New Jersey, 1908, p. 177.

The following table shows the production and imports of natural graphite from 1903 to 1907, inclusive:

*Production and imports of natural graphite, 1903–1907.*

| Year. | Production. | | | Imports. | |
|---|---|---|---|---|---|
| | Crystalline graphite. | Amorphous graphite. | Total value. | Quantity. | Value. |
| | *Pounds.* | *Short tons.* | | *Short tons.* | |
| 1903 | 4,538,155 | 16,591 | $225,554 | 17,928 | $1,207,700 |
| 1904 | 5,681,177 | 16,927 | 321,372 | 14,195 | 905,581 |
| 1905 | 6,036,567 | 21,953 | 318,211 | 17,457 | 983,034 |
| 1906 | 5,887,982 | 16,853 | 340,239 | 25,487 | 1,554,212 |
| 1907 | 4,947,840 | 26,803 | 296,970 | 22,939 | 1,777,389 |

## ARTIFICIAL GRAPHITE.

The production of artificial graphite, which was first put on the market in 1897, has increased in wonderful measure. Although produced by a single company, the output for 1907 was greater than the total output of flake graphite in the United States, and was of greater value than the combined production of flake and amorphous graphite. The company's product showed an increase in quantity of 29 per cent and in value of 42.7 per cent over the output of 1906. The following table shows the production and value of artificial graphite since 1903:

*Production and value of artificial graphite, 1903–1907.*

| Year. | Quantity. | Value. | Price per pound. |
|---|---|---|---|
| | *Pounds.* | | *Cents.* |
| 1903 | 2,620,000 | $178,670 | 6.82 |
| 1904 | 3,248,000 | 217,790 | 6.70 |
| 1905 | 4,591,550 | 313,980 | 6.83 |
| 1906 | 5,074,757 | 337,204 | 6.64 |
| 1907 | 6,590,000 | 481,239 | 7.30 |

## WORLD'S PRODUCTION.

The world's production of graphite for the years 1904, 1905, and 1906, as gathered from various government publications, is as follows:

*World's production of graphite, 1904, 1905, and 1906, in short tons.*

| Country. | 1904. | | 1905. | | 1906. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| United States | 19,768 | $321,372 | 24,971 | $318,211 | 19,797 | $340,239 |
| Austria | 31,548 | 386,082 | 37,937 | 274,154 | 42,016 | 293,615 |
| Canada | 452 | 11,760 | 541 | 17,083 | 446 | 18,780 |
| Ceylon | [a]29,187 | 2,110,873 | [a]34,319 | 2,307,042 | 40,320 | 3,406,550 |
| France | 17 | 130 | 110 | 1,351 | 276 | 2,433 |
| Germany | 4,171 | 40,122 | 5,424 | 49,742 | 4,470 | 47,122 |
| India | 3,647 | 81,288 | 2,603 | 82,085 | 2,912 | 46,709 |
| Italy | 10,764 | 44,542 | 11,654 | 52,104 | 11,910 | 61,162 |
| Japan | 238 | 18,026 | 230 | 18,201 | 155 | 12,191 |
| Mexico | 1,069 | 47,436 | 1,069 | 42,916 | 4,315 | 77,110 |
| Norway | | | | | 2,101 | 5,884 |
| Sweden | 61 | 1,755 | 44 | 1,276 | 41 | 1,197 |
| Queensland | | | 36 | 1,324 | 34 | 973 |
| Total | 100,922 | 3,063,386 | 118,938 | 3,165,439 | 128,793 | 4,315,965 |

[a] Exports.

# MAGNESITE.

## By CHARLES G. YALE.

### PRODUCTION.

The production of magnesite for the State of California represents all that is mined in the United States, but the consumption of the domestic material is still confined to the Pacific coast, since the cost of transportation from there to points east of the Missouri River is prohibitive, when the prices of the magnesite imported from Greece and Austria are considered. There was little change to be noted in 1907 from the conditions existing in 1906 in connection with this mineral and the output was not materially different. Since the close of 1907, however, prices have advanced somewhat, especially in calcined magnesite. Most of the domestic output is still derived from the deposits in Tulare County, where the two largest mines of the State are now being operated. Small quantities also come from Napa, Sonoma, and Riverside counties. The extensive deposits at the point where Alameda, Stanislaus, and Santa Clara counties unite were not productive in 1907. The company which operated them has a factory on the border of Oakland Harbor, which was badly damaged by the earthquake of 1906, and it had not fully been reconstructed in 1907. For this reason the mines which furnish the crude product were not worked in 1907.

The demand for this substance is mainly confined to the manufacturers of paper made from wood pulp, the magnesite acting as a digester for the fiber; to the manufacturers of carbonic acid gas; and to the manufacturers of artificial marble, flooring, tiles, and etc. None of the domestic material is made into magnesite brick, these brick at present being made from magnesite imported from Greece or Austria.

At the most important center of production, in the San Joaquin Valley near Porterville, the crude magnesite was worth about $3 per ton in 1907, but in San Francisco, the principal market, the price was $6.50 a ton. The paper manufacturers and those making artificial marble, tiles, etc., use only the calcined material; but the manufacturers of carbonic acid gas buy the crude, and after extracting the gas sell the calcined residue. This residue, not being subjected to a "dead roast," is not fully calcined, and some gas still remains in it.

Most of the magnesite produced at the Porterville deposits in the San Joaquin Valley is calcined on the spot, furnaces having been erected for that purpose. A new deposit near that point was opened in 1908, and a furnace put up. The calcined product is utilized by the paper manufacturers who own the mine. Aside from this mine, no new ones have been opened in California of late. That at Winchester in Riverside County made only test shipments in 1907, but it is being worked in 1908.

A few hundred tons were produced from the deposits at Cloverdale, Sonoma County, and a small quantity from Riverside County. There were also a few hundred tons derived from Alameda County; but, as stated, the bulk of the output continues to come from Tulare County. Some deposits of the State were prospected, but with the exception of that of South Tule, Tulare County, no new ones have been made productive. This South Tule deposit is owned by the Tulare Mining Company, a subsidiary of the Willamette Paper Company. The calcining plant established there has a capacity of 20 tons of calcined rock daily. The raw material is dumped from the mine cars into a large bin, from which it goes to the calcining furnace. The ore is hauled but a short distance from the mines to the furnaces, and from the furnaces it is conveyed to the railroad station by traction engines.

The California Magnesite Company owns 320 acres of land in Riverside County, a few miles from Winchester, and in 1908 established a factory in Los Angeles, where it will manufacture brick, tiling, etc. The sales of this company have thus far been confined to the city of Los Angeles. Another deposit, 35 miles east of Winchester, has been located by C. G. Van Fleet, of San Jacinto, but it has not yet been opened. A. W. Boggs, of Riverside, has purchased 320 acres near Winchester, on which deposits of magnesite have been found, but they have not as yet been developed. A factory has been established in San Francisco and another one in Los Angeles to make flooring, sink backs, drain boards, ornamental wainscoting, table tops, tiles, etc. The business of these factories is growing rapidly, and some of the artificial stone made up into wainscoting is very handsome and ornamental. Larger quantities are being used as the product becomes known. The factory in Los Angeles at first used imported material, but is now using the California product.

The total domestic output of crude magnesite in 1907 was 7,561 short tons, valued at $3 per ton at points of production. Delivered at San Francisco it costs $6.50 a ton. The total value at the mines in 1907 was $22,683 and at San Francisco $49,147. In 1906 the output of crude was 7,805 tons, valued at $23,415, the price at the mines being $3 per ton. The following table shows the quantity and value of the domestic output since 1891:

*Quantity and value of crude magnesite produced in the United States, 1891–1907.*

| | | | | | |
|---|---|---|---|---|---|
| 1891..........short tons.. | 439 | $4,390 | 1900..........short tons.. | 2,252 | $19,333 |
| 1892..............do.... | 1,004 | 10,040 | 1901..............do.... | 3,500 | 10,500 |
| 1893..............do.... | 704 | 7,040 | 1902..............do.... | 2,830 | 8,490 |
| 1894..............do.... | 1,440 | 10,240 | 1903..............do.... | 3,744 | 10,595 |
| 1895..............do.... | 2,220 | 17,000 | 1904..............do.... | 2,850 | 9,298 |
| 1896..............do.... | 1,500 | 11,000 | 1905..............do.... | 3,933 | 15,221 |
| 1897..............do.... | 1,143 | 13,671 | 1906..............do.... | 7,805 | 23,415 |
| 1898..............do.... | 1,263 | 19,075 | 1907..............do.... | 7,561 | 22,683 |
| 1899..............do.... | 1,280 | 18,480 | | | |

It requires 2.4 tons of crude magnesite ($MgCO_3$) to make 1 ton of calcined ($MgO$). The calcined magnesite is worth from $12 to $20 per ton, according to the roasting given it; the average price in 1907 may be stated as about $17 in San Francisco.

A very much larger output of magnesite could be made, provided there was sufficient demand. There is little variation in the price of magnesite. Increased production indicates increased use, but no special change in price.

## IMPORTS.

The imports of magnesite into the United States in 1906 and 1907 were as follows:

*Imports of magnesite into the United States in 1906 and 1907, in pounds.*

| | 1906. | | 1907. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Magnesia: | | | | |
| Calcined, medicinal | 30,788 | $5,689 | 49,489 | $9,005 |
| Carbonate of, medicinal | 39,487 | 5,844 | 85,467 | 3,994 |
| Sulphate of, or Epsom salts | 5,830,224 | 22,471 | 4,532,713 | 16,256 |
| Magnesite. | | | | |
| Calcined, not purified | 141,314,682 | 740,585 | 151,137,661 | 688,371 |
| Crude | 39,477,766 | 122,908 | 46,878,740 | 186,968 |

In addition, magnesium not made up into articles was imported to the value of $14,332 in 1907, against $8,706 in 1906.

It will be noted that there was an increase in 1907 in the quantity of both crude and calcined material imported, indicating an increased consumption in the United States. These imports came from Greece and Austria, mainly from the former country. Only a small proportion of what is used in the United States in mined in this country. It is not that the mines of California are unable to make a larger output, but that the freight rates from San Francisco to eastern cities are such as to prevent competition with the foreign material at the points of greatest consumption in this country.

## USES.

In the crude state, magnesite is used for the manufacture of carbon-dioxide gas; calcined, it is used in the manufacture of paper from wood pulp; and as a refractory material it is used in brick or plaster form for lining furnaces, covering steam pipes, as artificial lumber, as composite stone for lithographing, as an adulterant for paint, etc. Magnesium chloride is an excellent bleaching agent. The light carbonate or magnesia (alba levis) is used for medicinal and toilet purposes. The sulphate, known as Epsom salts, is mainly used in warp sizing or weighting in cotton mills, and lesser quantities are used for medicinal purposes. The hydrate is used in sugar manufacture.

Calcined magnesia, generally in the form of brick, is now universally recognized as the best material for lining basic open-hearth furnaces, cement kilns, etc. It may be employed to advantage wherever high temperatures and chemical reactions are usually detrimental to dolomite, chromite, and silica brick. The distinctive characteristics of a magnesite lining are durability, freedom from moisture and silicic acid, and resistance to corrosion when exposed to the action of basic slags and metallic oxides.

## OCCURRENCE.

Aside from Greece and Austria, magnesite is found in Silesia, Germany; Minsau, Hungary; in Swedish Lapland; in the Ural Mountains in Russia; in Quebec, Canada; in India; in the Baberton district, Transvaal, South Africa; and near the district of Lourenço Marquez, South Africa. Magnesite occurs in the United States in Massachusetts, Maryland, Pennsylvania, and California, but only in the last-named State have the deposits been commercially utilized.

No magnesia has thus far been made from the domestic material, though it is about to be produced in California. The two factories making light magnesia in Milwaukee, Wis., use for the purpose a dolomite carrying 43½ to 44 per cent of magnesia. They obtain the dolomite laid down for about $4 per ton, while imported magnesia costs at that point $9 to $10 per ton, hence magnesite is not yet used for this purpose.

Experience in California shows that where the home market is so limited and the prices realized are so low, the magnesite properties nearest the railroads have a distinct advantage over those distant from them. Long hauls by team add so materially to cost that deposits requiring hauling are now all idle. Of some half a hundred known deposits of magnesite in California, only a few are now being mined, though any marked advance in price or in demand would lead to the starting up of several more of the quarries.

# MICA.

By Douglas B. Sterrett.

## INTRODUCTION.

The name mica is given to a group of minerals which have certain physical properties in common. Prominent among these are ready cleavage, whereby the minerals can be split into extremely thin sheets, and the flexibility and elasticity of these sheets and their comparative softness, which is combined with a certain toughness. These properties, along with the others, such as the occurrence of plates or blocks producing sheets several square inches in cross section, light color, transparency, nonconductivity of electricity, and resistance to heat, render certain varieties of mica of great value in the industrial world.

The two varieties largely used are muscovite, or potash mica, and phlogopite, or magnesia mica. Other varieties, for which there are limited uses or no use at all in their natural state are biotite, a black or dark-brown iron-magnesia mica; lepidolite, or lithia mica, used principally as a source of lithia or as an ornamental stone; roscoelite, or vanadium mica, used as a source of vanadium; paragonite, or soda mica; zinnwaldite, or iron-lithia mica. Muscovite, phlogopite, and biotite are practically the only varieties which occur in quantity and in sheets of sufficient size to be of commercial value, though biotite is rarely if ever industrially applied. Muscovite is slightly harder and more brittle than phlogopite, though generally lighter in color. Muscovite may be white, gray, yellow inclining to amber, brown, red, or green in color. Brown and red muscovite, when of the proper shades, are often call "rum" and "ruby" mica. Phlogopite may be silvery gray, yellow, brown, or black, and some varieties present a coppery appearance. The trade name of phlogopite is "amber" mica.

## OCCURRENCE BY STATES.

The muscovite mica of commerce is obtained only from pegmatite in regions of crystalline metamorphic or igneous rocks. Pegmatite is a very coarse-textured rock whose composition is closely allied to that of granite, into which it sometimes grades. The minerals composing pegmatite are feldspar and quartz in varying proportions, with or without mica and other accessory minerals. The minerals of pegmatite are crystallized out in large masses, some specimens showing a typical coarse granitic texture, or in veinlike bands or irregular segregations. Some individual crystals of feldspar measure several yards in length, and mica also occurs in crystals several feet in dimensions. Of the numerous accessory minerals found in pegmatite—some very rare—certain ones are of value. These are the rare-earth minerals, or various gem minerals, as tourmaline, beryl, spodumene, garnet, etc. It is not unusual to obtain some of these minerals with the mica. Thus, in North Carolina, gem aquamarine, blue beryl, and specimen material have been found in the mica mines. In South Dakota the same pegmatite has yielded mica, cassiterite, and columbite.

Pegmatites valuable for their mica contents are generally found in metamorphic gneisses and schists, in which they occupy various positions. In some occurrences the pegmatites follow the bedding planes of the country rock for considerable distances; in others they cut the strike of the inclosing rock through part or all of their extent. Many pegmatite masses are very irregular in shape and continuity, and some exhibit the same structures as the country rock. Pegmatite that is commercially valuable for mica commonly occurs in overlapping lenticular-shaped bodies and sheets of more persistent extent. The deposits range from a fraction of an inch up to many yards in thickness, and the length of the lens-shaped masses may be from two or three times to more than twenty times their thickness. The minimum thickness of a pegmatite body which can be profitably worked for mica might be arbitrarily placed at from 1 to 2 feet for rich and regular veins.

The mica crystals occupy various positions in pegmatite masses, and no positive rule can be made for finding them. Where the pegmatite has a typical granite texture, the mica may be found evenly distributed through it. Often the larger crystals will be found either in clusters at intervals through the "vein," in places partly connected by streaks of small crystals, or along one or both walls of the pegmatite. Where there is a quartz streak within the pegmatite, the mica occurs on either or both sides of it, being partly embedded in the quartz or occupying any of the positions noted above in the remaining portion of the pegmatite.

Commercially valuable deposits of phlogopite are not known to occur in the United States. Deposits carrying commercial sizes of muscovite mica have been found in the following States of the United States: Alabama, Arizona, California, Colorado, Connecticut, Georgia, Idaho, Maine, Maryland, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, South Carolina, South Dakota, Virginia, Wyoming, and a few other States. Brief notes on the occurrence of mica in several of these States are given below.

*Alabama.*—The mica deposits of the northern part of Randolph County, in northeastern Alabama, are briefly described by W. F. Prouty.[a] They occur in a belt of Archean schists in the vicinity and to the south of Micaville. The deposits consist of pegmatite which in some places is composed largely of orthoclase feldspar and in others chiefly of quartz. Those pegmatites which contain large amounts of quartz appear to be the richer in mica. The latter mineral more often occurs embedded in the quartz than in the feldspar, though large crystals are generally found along the wall rock or between masses of feldspar and quartz. The minerals most commonly associated with the mica, besides feldspar and kaolin, are tourmaline and cyanite. The pegmatite masses lie principally in the bedding planes or schistosity of the mica schist, which is often highly garnetiferous near the contact. Locally the pegmatites occur in lenticular masses, though the leads can be traced long distances.

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[a] Mica in Alabama: Mines and Minerals, December 1907.

The mica deposits of Alabama have been opened at a number of places in times past, though they have only been worked in a limited way. In view of the large number of deposits in which high-grade mica has been found, Mr. Prouty expects to see a large production from Alabama within the next decade.

*California.*—Mica has been mined in Ventura County,[a] Cal., 58 miles from Bakersfield, at the Mount Alamo mine. The occurrence is in pegmatite which has a mica-schist hanging wall and a granite foot wall. The mining is reported as having been carried to a depth of 200 feet, though the pegmatite formation is somewhat broken and faulted. Clear sheet mica up to 4 by 10 inches in size was obtained, but the greater part of the product was shipped as scrap to the company's factory at West Berkeley.

*North Carolina.*—For a number of years North Carolina has led in the production of mica in the United States. Mines have been worked in over twenty counties in the western part of the State. The principal production has come from the counties northwest of the Blue Ridge Mountains, and among them the following have been important producers: Mitchell, Yancey, Macon, Jackson, Haywood, and Ashe. During 1907 there was a considerable production from Cleveland and the adjoining counties, and from Stokes County, all in the Piedmont plateau region to the southeast of the Blue Ridge. Very large blocks of mica have been found in the mines of some of these counties. During 1907 a crystal of mica was found in the mine of the Franklin Kaolin and Mica Company, at Iotla Bridge, Macon County, that was 29 inches wide, 36 inches long, and about 4 feet thick. This crystal was not solid, however, and the perfect sheets obtained from it were considerably smaller than its area.

As a rule, the methods of mining mica in North Carolina are simple. A deposit is opened by crosscuts or trenches along the outcrop, and the mica is followed, wherever it may lead, by inclines, shafts, drifts, and stopes. Since the occurrence of mica in pegmatite is often very irregular, the workings are apt to be very unsystematic. It is unusual, and as a rule inadvisable, to open a mica mine in North Carolina by a shaft or adit calculated to cut the "vein" at a certain point, unless a careful test has first proven the continuity and regularity of the pegmatite; for the latter may have pinched out, changed its dip or strike, or been folded back on itself, so that the development work may fail to reach it; or the "vein" may be found barren of mica when finally cut.

Mica is found in several types of pegmatite[b] in North Carolina. Some of these appear to be regular dikes with a very coarse granitic texture, while others are doubtless veins. In the latter type there is generally a decided banding of the two prominent minerals of pegmatite; that is, the feldspar and the quartz. These minerals occur in separate sheet-like masses in the pegmatite, lying parallel with its walls, while the mica is generally found in the feldspar next to the quartz or walls.

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[a] Min. and Sci. Press, February 4, 1905.

[b] Sterrett, Douglas B. Mica deposits of western North Carolina: Bull. U. S. Geol. Survey No. 315, 1906, pp. 400–422.

*South Dakota.*—Good mica deposits are known to occur in the Black Hills in Custer and Pennington counties, S. Dak. The pegmatites of this region have attracted considerable attention because of their large size and their associated minerals. The Etta mica and tin mine has probably been the most noted for the latter reason, for besides containing those two minerals, spodumene crystals more than 30 feet long occur through the pegmatite, while beryl, columbite, and tourmaline also occur in masses of unusual size. Another mineral of interest found in the pegmatites of several other mines in the Black Hills, as well as the Etta, is wolframite. The sheet mica in this region is said to be of good color and quality, though there is a rather large proportion of "ruled" and "wedge" shaped crystals.[a] Occasionally the mica content of the pegmatites in the Black Hills amounts to 8 or 10 per cent, though it is generally much less.

*Virginia.*—In a report on the mineral resources of Virginia, prepared for the Jamestown Exposition in 1907, Dr. T. L. Watson gives the following localities and counties in which mica has been mined: Near Amelia and Jetersville, Amelia County; near New London, Bedford County; near Goochland, Goochland County; south of Chatham, Pittsylvania County; in Amherst County; at Ridgeway, Henry County; near Hewlett, Hanover County. Indications of mica occur also in Powhatan, Cumberland, Caroline, Buckingham, Spottsylvania, and Franklin counties.

The Jefferson mine near Amelia, opened in 1873, was the first mine worked for mica in Virginia, and was soon followed by the Rutherford mine, also near Amelia, and the Schlegal mine near Jetersville. The only mica mines in Amelia County regularly worked during recent years have been the Pinchback and the Schlegal. The Pinchback mine has been worked by over half a dozen openings, in the last of which, made in 1906, the pegmatite is shown to be 40 feet thick. The feldspar toward the walls is entirely kaolinized to a depth of 28 feet, and all of it, though only partially kaolinized, is shipped to pottery works when the mine is in operation. The Schlegal mine was worked by a large open cut and a shaft 100 feet deep, with some drifting. The last work was done about six years ago and, besides mica, furnished feldspar for pottery works. This feldspar was ground in a mill at the mine before shipping. The pegmatite formation is nearly 30 feet thick and cuts irregularly across the strike of the country gneiss.

Much of the rock of the Amelia mica region is covered with a mantle of residual soil. The mica occurs in pegmatites cutting a country rock of thinly foliated, dark biotite gneiss, which in some places has an "augen" texture. The proportion of feldspars, quartz, and mica in the pegmatite is quite variable. The varieties of feldspar found are orthoclase, microcline, and albite. A number of accessory rare minerals have been found in the Amelia County pegmatites, among which are microlite, columbite, helvite, monazite, allanite, beryl, zircon, and good specimens of spessartite garnet. The size and quality of the sheets of mica that have been found are reported satisfactory, patterns of 12 by 14 inches having been cut.

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[a] Holmes, J. A. Mica deposits in the United States: Mineral Resources for 1898. Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 (cont'd), p. 705.

*Wyoming.*—According to Sydney H. Ball,[a] mica deposits were located in the Hartville uplift region in Wyoming as early as 1881, near the Haystack Hills. Though prospecting and assessment work have been carried on to the present time, there have been practically no shipments to the markets. The principal difficulties to mica mining in this region are the high freight rates to the markets, including a haul costing $1.25 per ton to the railroad. The same difficulties prohibit the shipment of feldspar.

The mica occurs in pegmatite cutting a schistose country rock. The pegmatite is composed of orthoclase, microcline, and albite feldspar, and quartz, muscovite, black tourmaline, beryl, brown garnet, and biotite, all coarsely crystallized. The distribution of the minerals is somewhat even through the pegmatite, though locally the mica occurs in bunches. The pegmatites, carrying large sheets of mica, range in width from 5 to 18 feet, and are quite irregular along the strike and dip.

## USES.

Mica has a wide industrial application. In the form of sheet mica it is extensively used in electrical apparatus instead of glass, and small quantities are used for decorative effects. Large quantities of ground mica are used for decorative purposes, the manufacture of lubricants, and in electrical insulation.

For insulating purposes in electrical apparatus there is nothing superior to mica. Its perfect cleavage, flexibility, elasticity, infusibility, toughness, and softness, combined with its high nonconductivity to electricity, render the sheets especially serviceable for a variety of purposes, as for insulation between the copper segments of the commutators for direct-current dynamos and motors, in armature frames, in transformers, induction coils, lightning arresters, switch boxes, fuse blocks, incandescent-lamp sockets, arc lamps, etc. For insulation between commutator segments the phlogopite mica is superior to muscovite, since it is of the proper hardness to wear down evenly with the copper, while the harder muscovite does not wea down so rapidly and leaves a little ridge above the copper bare, thereby endangering the machine by sparking. Both varieties of mica are satisfactory for building into mica board or "micanite," as it is called. This material is prepared by splitting the mica into thin sheets, systematically placing them together with shellac, and then subjecting the whole to pressure. In this way large composite sheets are made, which are as suitable, in most cases, as single sheets of mica for insulating purposes. "Micanite" can be bent, rolled into tubes, or cut, and of course can be obtained in very large sheets. Small sizes of sheet mica can be punched to the proper size and shape for many purposes, as in washers for lamp sockets, and to such uses large quantities are applied.

The first use of mica was probably in the windows of dwellings and as fronts and chimneys for lanterns. Later large sheets of mica were used in the fronts of stoves and in stove doors and in the lights of warships, where glass would not stand the jar of heavy guns. The principal uses of mica instead of glass at present are in stove lights, incandescent gas-lamp chimneys, and miners' lamps. In the early days large sheets were commonly employed in the manufacture of stoves, while at present the same result is obtained by employing several smaller sheets. The manufacture of gas and oil stoves creates a demand for considerable sheet mica. A limited use of small sheet mica is made in phonograph diaphragms, stonecutters' spectacles, etc., while sheets of various sizes are used in the manufacture of small fancy boxes and other novelties.

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[a] Mica in the Hartville uplift, Wyoming: Bull. U. S. Geol. Survey No. 315, 1907, pp. 423–425.

The presence of imperfections in sheet mica, such as poor cleavage or inclusions of foreign material, depreciates its value. Specked or stained mica is not satisfactory for use in stoves or lamp chimneys. The use of black-specked mica in electrical machinery, where the specks are due to magnetite between the laminæ, is limited to machinery using currents of low voltage, since high potential currents might break down the insulation through the magnetite specks.

Of the large quantities of scrap mica ground each year, much is used for decorative purposes in brocade paints of silver, gold, and bronze colors for wall papers, etc. In the manufacture of lubricants ground mica has been found especially suitable, and large quantities are used in the heavier varieties for car-axle lubrication, etc. Ground mica mixed with shellac has been found serviceable in making molded forms for electrical insulation, such as handles, wire insulators, etc. This form is called "molded mica," and is capable of a large variety of uses.

## PRODUCTION BY STATES.

The total value of the production of mica in the United States in 1907 amounted to $392,111. This production came from 11 States—North Carolina, South Dakota, Alabama, South Carolina, Colorado, New Hampshire, Idaho, Georgia, Virginia, New Mexico, and Maine—here named in order of the value of their output. Of these States, Alabama, South Carolina, Georgia, and Maine reported no production in 1906, while Connecticut is credited with no production in 1907 as against a small one in 1906.

The production of sheet mica amounted to 1,060,182 pounds, valued at $349,311, a decrease in quantity of 412,918 pounds and an increase in value of $82,063, as compared with 1906. The decrease in quantity and the increase in value are due to the fact that, as reported to the Survey, in 1907 a larger proportion of the mica was manufactured than in 1906.

The production of scrap mica amounted to 3,025 short tons, valued at $42,800, an increase of 1,526 tons in quantity and of $20,058 in value over 1906. The price per ton was $14.15 as compared with $15.27 in 1906.

It is difficult to separate the figures of production for sheet mica from those for scrap mica, since the material used for sheet by one producer might be ground as scrap by another. Thus sheets of only an inch and a half in diameter may be used for punching out washers by one manufacturer, while sheets up to 2 or 3 inches in diameter may be ground along with waste mica by another. After the larger sheet mica has been removed from a stock of rough mica the remainder is sometimes sold as scrap. All of the latter is not necessarily ground, however, as the purchaser may use a considerable quantity to manufacture small sheet and punch mica. In such cases the value is considerably more than that reported for scrap.

The mica industry in the United States was in an especially flourishing condition during the first part of 1907 in many of the producing areas. During the latter part of the year activity in mica production was but slightly decreased by the panic. To judge from conditions during the first part of 1908, it is doubtful whether the effects of the panic will cause a very great falling off in output.

*North Carolina.*—North Carolina is credited with a production of $225,206 worth of mica, as follows: 645,221 pounds of sheet, valued at $209,956, and 1,371 short tons of scrap, valued at $15,250. This production came from the following counties, named in the order of the value of their output: Mitchell, Yancey, Macon, Jackson, Haywood, Transylvania, Ashe, Lincoln, and Watauga. Over one-half of the production came from Mitchell and Yancey counties and over one-third from Macon, Jackson, and Haywood counties. An interesting feature of the mica industry in North Carolina is the increasing quantity of mica that is manufactured before being shipped to the markets. This is true not only of sheet mica, but of scrap mica also. Part of the scrap, however, is shipped out of the State for grinding, much of it going to Richmond, Va., for this purpose.

*South Dakota.*—There was a large increase in the production of mica in South Dakota in 1907, the value of which amounted to nearly one-third of the total for the United States. This increase is due principally to the extensive operations of the Westinghouse Electric and Manufacturing Company near Custer. This company, through its agent, Mr. W. J. Longmore, installed a complete electrical plant for the operation of its four mica mines. Some of the mica is manufactured at Custer, S. Dak., and the remainder at Denver, Colo., in a plant operated under the name of the Laurentide Mica Company (Limited).

*Alabama.*—The appearance of Alabama in third place in the list of States producing mica in 1907 is due to the operations of the Great Southern Mica Company, of Cleveland, Ohio. This company commenced operations near Heflin, in Randolph County, about the 1st of July, 1907. A plant has been erected for the manufacture of both sheet and scrap mica, for which latter a grinding mill was erected and started in January, 1908.

*South Carolina.*—The production of mica in South Carolina came from Greenville County, where three mines were worked during part of 1907. Two of these, one at Reedy River and the other near Greenville, were operated by Mr. C. H. Wolford, who reports other good prospects in the region. According to Earle Sloan,[a] there are a number of localities in which mica has been found in South Carolina.

These are located in Oconee, Anderson, Pickens, Abbeville, Greenville, and Spartanburg counties. Feldspar, suitable for pottery works, occurs with the mica in some of the deposits.

*Colorado.*—Though the production of mica in Colorado was somewhat less in 1907 than in 1906, there was still considerable activity in the mica industry in that State. The Canyon City Mica Mills Company, mentioned in this report for 1906, completed its plant for manufacturing sheet and scrap mica and commenced the preparation of mica for the market. During 1907 rough mica for manufacture was bought by this company, though it also expects to operate mines of its own.

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[a] A catalogue of the mineral localities of South Carolina: Bull. 2, South Carolina Geol. Survey, 1908, pp. 142-149.

*New Hampshire.*—The production of mica in New Hampshire was less in 1907 than in 1906, both in quantity and in value. The output came from Grafton and Cheshire counties. The principal producer in this State was the General Electric Company, operating mines in Alexandria and Groton, with a factory at Bristol.

*Idaho.*—The value of the production of mica in Idaho reported in 1907 was greater than in 1906. The principal producer was the Spokane Mica Company, which operated in Latah County. This company reports that a railroad has been built into the mica field of Latah County, rendering a number of good mica deposits accessible without the 20-mile wagon haul formerly necessary.

*Georgia.*—The production of mica in Georgia came from Lumpkin and Union counties, where the Pitner Mica Company, of Two Run, operated a part of the year.

*Virginia.*—The production of mica in Virginia was considerably less in 1907 than in 1906. It came from Martinsville, in Henry County; Hewlett, in Hanover County; and Amelia, in Amelia County. No production was reported from Bedford County in 1907, though there was a good production in 1906. The production of mica in Virginia during 1908 should show a large increase, as new companies have formed to operate during that year, and some of the companies producing in 1907 perfected their equipment only at the end of the year or in the early part of 1908. Among the new companies are the Corson Mica Company and the Pittsburg Mica Company, to work mines in Amelia and Henry counties, respectively. The latter company has erected a plant for the manufacture of stove and electric sheet mica and a mill for grinding scrap mica at Ridgeway. According to T. L. Watson,[a] the workings consist of an open cut about 100 feet long and 40 feet deep, with much crosscut work, on a pegmatite 8 feet wide. Among those companies producing at the end of 1907 were the Hanover Mica Company, at Hewlett, in Hanover County, and the Henry Mica Corporation, of Columbus, Ohio, with mines at Martinsville, Henry County, where the latter company will install a grinding mill during the present year.

*New Mexico and Maine.*—The production of mica from New Mexico and Maine was very small and was reported as scrap. The production in New Mexico came from Ojo Caliente, in Taos County, and that in Maine from the tourmaline mine at Mount Mica, Oxford County.

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[a] Mineral Resources of Virginia, Virginia Jamestown Exposition Committee, 1907 pp. 278-285.

The production of mica in the United States since 1880 has been as follows:

*Production of mica in the United States, 1880–1907.*

| Year. | Sheet mica. |  | Scrap mica. |  | Total value. |
|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. |  |
|  | *Pounds.* |  | *Short tons.* |  |  |
| 1880 | 81,669 | $127,825 | ........ | ........ | $127,825 |
| 1881 | 100,000 | 250,000 | ........ | ........ | 250,000 |
| 1882 | 100,000 | 250,000 | ........ | ........ | 250,000 |
| 1883 | 114,000 | 285,000 | ........ | ........ | 285,000 |
| 1884 | 147,410 | 368,525 | ........ | ........ | 368,525 |
| 1885 | 92,000 | 161,000 | ........ | ........ | 161,000 |
| 1886 | 40,000 | 70,000 | ........ | ........ | 70,000 |
| 1887 | 70,000 | 142,250 | ........ | ........ | 142,250 |
| 1888 | 48,000 | 70,000 | ........ | ........ | 70,000 |
| 1889 | 49,500 | 50,000 | ........ | ........ | 50,000 |
| 1890 | 60,000 | 75,000 | ........ | ........ | 75,000 |
| 1891 | 75,000 | 100,000 | ........ | ........ | 100,000 |
| 1892 | 75,000 | 100,000 | ........ | ........ | 100,000 |
| 1893 | 51,111 | ........ | 156 | ........ | 88,929 |
| 1894 | 35,943 | ........ | 191 | ........ | 52,388 |
| 1895 | 44,325 | ........ | 148 | ........ | 55,831 |
| 1896 | 49,156 | 65,441 | 222 | $1,750 | 67,191 |
| 1897 | 82,676 | 80,774 | 740 | 14,452 | 95,226 |
| 1898 | 129,520 | 103,534 | 3,999 | 27,564 | 131,098 |
| 1899 | 108,570 | 70,587 | 1,505 | 50,878 | 121,465 |
| 1900 | 456,283 | 92,758 | 5,497 | 55,202 | 147,960 |
| 1901 | 360,060 | 98,859 | 2,171 | 19,719 | 118,578 |
| 1902 | 373,266 | 83,843 | 1,400 | 35,006 | 118,849 |
| 1903 | 619,600 | 118,088 | 1,659 | 25,040 | 143,128 |
| 1904 | 668,358 | 109,462 | 1,096 | 10,854 | 120,316 |
| 1905 | 924,876 | 160,732 | 1,126 | 17,856 | 178,588 |
| 1906 | 1,423,100 | 252,248 | 1,489 | 22,742 | 274,990 |
| 1907 | 1,060,182 | 349,311 | 3,025 | 42,800 | 392,111 |

## IMPORTS AND EXPORTS.

The imports of unmanufactured and trimmed sheet mica into the United States during 1907, as reported by the Bureau of Statistics of the Department of Commerce and Labor, were less than in 1906 by 728,048 pounds in quantity and $117,349 in value. With the exception of 1906, the imports were larger in 1907 than in any other year recorded. The quantity and value of mica imported into the United States annually from 1903 to 1907, inclusive, are shown in the following table:

*Mica imported and entered for consumption in the United States, 1903–1907, in pounds.*

| Year. | Unmanufactured. |  | Cut or trimmed. |  | Total. |  |
|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 1,355,375 | $288,783 | 67,680 | $29,186 | 1,423,055 | $317,969 |
| 1904 | 1,085,343 | 241,051 | 61,986 | 22,663 | 1,147,329 | 263,714 |
| 1905 | 1,506,382 | 352,475 | 88,188 | 51,281 | 1,594,570 | 403,756 |
| 1906 | 2,984,719 | 983,981 | 82,019 | 58,627 | 3,066,738 | 1,042,608 |
| 1907 | 2,226,460 | 848,098 | 112,230 | 77,161 | 2,338,690 | 925,259 |

A small quantity of mica is exported each year, for which figures have not been obtained for calendar years.

## PRICES.

The average price of sheet mica for the United States during 1907, as deduced from the total production, was 33 cents per pound, as compared with 17.7 cents in 1906. The average prices per pound of sheet mica as reported in the production from several States were as follows: Idaho, $1.50; Alabama, 72 cents; South Dakota, 33.4 cents; North Carolina, 32.5 cents; South Carolina, 30 cents; New Hampshire, 20.6 cents; Virginia, 17.7 cents; Colorado, 9 cents. With the exception of Colorado, the average price of sheet mica in all of these States was considerably higher in 1907 than in 1906, and the figures bring out well the fact that a much larger proportion of manufactured mica was included in these reports.

The average price of scrap mica during 1907, as obtained from the table of production, was $14.15 per ton, as compared with $15.27 in 1906. The average price paid for scrap mica in North Carolina during 1907 was $11.12 per ton, an increase of 55 cents over 1906. In the remaining States the average price was $16.65 per ton. The prices of scrap mica reported by dealers in the several States are so variable, dependent on their transportation and market facilities and on the grade of mica, that it is impossible to state a definite price. The price paid for a certain lot of mica sold as scrap is sometimes high, since the purchaser may obtain much small sheet mica from it before grinding. The waste from manufactured sheet mica also is more suitable for grinding than small, rough, refuse mica from the mine, since it is cleaner and contains less foreign material, as dirt, quartz, and other minerals.

## FOREIGN PRODUCTION.

### CANADA.

The exports of mica from Canada[a] during 1907 are given as 1,117,010 pounds, valued at $422,172. This is a decided decrease in quantity and value from the exports of 1,826,000 pounds, valued at $581,919, reported for 1906.

### INDIA.

The exports of mica from India[b] in 1906 amounted to 54,193 hundredweight, valued at £258,782, as compared with 25,837 hundredweight, valued at £142,008, in 1905. The weight of exports here given for 1905 is considerably less than that published in this report in Mineral Resources for 1906, a difference due to an error in the figures published by the Geological Survey of India for 1906. The production of India mica came from the provinces of Madras, Bengal, and Rajputana, where an average of about 15,723 people were engaged in the mica industry.

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[a] Preliminary Report of the Mineral Production of Canada for 1907: Mines Section, Geol. Survey Canada, 1907.

[b] Rec. Geol. Survey of India, vol. 36, pt. 2, 1907.

# MINERAL WATERS.

By Samuel Sanford.

## SCOPE OF STATISTICS.

In collecting and tabulating the data given in the following account of the mineral-water trade of the United States during 1907 the same general plan has been followed as in assembling the statistics for 1906. In particular, there has been no change in the manner of compiling the totals showing the condition of trade by States. The term mineral water has been given the meaning defined in the report for 1906, and the valuation of table and mineral waters separately and the collection of details regarding springs at resorts, first attempted in the 1905 report by Mr. M. L. Fuller, have been continued. More attention, however, has been paid to separating from the returns made by producers the water used in making carbonated beverages, and some figures indicating the quantity of spring water thus used are published on a following page. The magnitude of the so-called soft-drink business and the endeavor to eliminate from State totals the water sold as something else than water have caused apparent declines in the mineral-water output of some States. Attention is called to these changes in the discussion of the year's production.

## DEFINITION OF MINERAL WATER.

As ordinarily used, the term mineral water implies water chemically different from the supplies furnished by the wells and springs of a particular locality. A chemist might define a mineral water as one having a large percentage of salts in solution, and a physician might define it as one prescribed in the treatment of some disorder of the human system. In this report, however, the basis of classification is commercial, and the mineral waters mentioned include those that contain a large percentage of solids in solution as well as those that have a very low content of dissolved salts. In compiling the totals of production by States, the output of a spring that is odorless, tasteless, and is not credited with therapeutic value has been added to the returns from a spring supplying water that has an unpleasant taste or a pronounced physiologic effect, the essential thing being that the water was an article of commerce. The fact that a spring owner reported that the water he sold was not " mineral " was not considered of importance. Neither was source taken into consideration, both natural springs and artesian wells being classed as springs. On the other hand, water distributed by public supply systems, water used for bathing, or water furnished without extra charge to guests at hotels or patients at sanitariums has been excluded, as also water used in making sweetened beverages. In short, the statistics given in this report refer to water sold as water, still or carbonated, in bulk or in bottles.

## MEDICINAL AND TABLE WATERS.

The total values of the medicinal and table waters sold in this country in 1907 are given separately, but this does not imply that the classification is a rigorous one based on differences in chemical composition. The exact physiologic effects of many spring waters widely recommended in the treatment of various disorders is a matter still in doubt. Some waters low in mineral content contain elements that act powerfully on the human system, and other waters much more highly mineralized contain elements that are relatively inert; hence the therapeutic value of a water need not depend on the total amount of mineral matter in solution. Moreover, the purest of spring waters may have their place in the treatment of disease because they are light, palatable, and refreshing. Hence many spring waters are sold for both medicinal and table use, as the statements of producers show.

The medicinal waters may be divided into three classes—the purgative waters, some of which are widely advertised, the less strongly mineralized, but even more advertised, " lithia " waters, and the sulphureted waters, little sold in bottles but drunk in large quantities at many resorts. The strictly table waters comprise those for which no other value is claimed than that they are wholesome and pleasant. They are less advertised than the medicinal waters, but as they are used for factory, office, and family supply and are largely distributed in carboys, their total sales reach millions of gallons. Between the strictly medicinal and the strictly table waters comes the output of a great number of springs, in which is included the water of what are probably the most advertised springs and wells in this country. This water is largely sold carbonated in bottles—quarts, pints, and splits—for bar and hotel trade.

## CONDITIONS AND TENDENCIES IN THE MINERAL-WATER TRADE.

Though the fact is not brought out by the table giving the production for the past twenty-five years, owing to changes made since 1904 in the classification of mineral waters, yet the year 1907 was undoubtedly the most prosperous one in the history of the trade. Several causes helped—the industrial prosperity of the country since 1898, the immense amount of advertising done by various producers, the increased efforts made to attract guests to hotels at springs and to sanitariums where hydrotherapy is part of the course of treatment, and, most important of all, the greater interest in pure drinking water.

The financial depression that unsettled business in the fall of 1907 evidently came too late to have much effect on the year's trade, but few spring owners reporting a decrease in sales on account of it. Undoubtedly the following period of falling values will have an effect on the trade of 1908, but there is every reason for believing that in ensuing years the trade will expand enormously.

In spite of the substitution of filtered water for the present polluted supplies at many cities, spring and well waters will be in demand for their lightness and palatableness, while the growing tendency toward specialized methods in the treatment of disease and the increasing interest in hydrotherapeutics are assurances of prosperity for many springs.

The tendencies of our industrial progress are manifest, however, in the mineral-water business. As in other branches of trade, the establishments investing the most capital and showing the most sagacity in securing and holding customers are bound to sell the most water. Yet this does not mean that all smaller producers are to be forced out of business. Many owners of medicinal springs will continue to sell their small annual totals, satisfied with the profits made from the successful conduct of hotels and sanitariums, and hundreds of owners of other springs will find profit in supplying a local demand for pure and agreeable drinking water. In fact, the number of producers will increase rather than diminish. Still, there will be some failures, for the investment necessary to put a mineral water on the market is much greater than many people suppose. Bottling, labeling, advertising, and distributing, all call for money.

## SPRINGS AS RESORTS.

While there are in several States springs that have long been famous as resorts, where great hotels during the season shelter thousands of guests, and while at other springs sanitariums have been established with every modern appliance for the medicinal use of the waters, yet there is room for new resorts. The United States has a climate as varied as that of any country in Europe and a much wider range of mineral springs, but the foreign spas attract thousands of American visitors who find what they can not find at home. In comparison, our springs lack attractions; less has been done to beautify the surroundings, and the present methods of using the water leave much to be desired. For a guest to drink as much of a strongly mineralized water as suits him, at whatever time he has the whim, without regard to the character of the water, his diet, or his mode of living at the resort, is absurd. The proprietors of the springs at certain of our famous resorts can do themselves no greater benefit than to impress on visitors the medicinal character of the waters and the importance of rational use. There is also opportunity for improvement in other directions, as in the development of springs and the prevention of waste and of the deterioration of quality by excessive use. The controversy at Saratoga Springs, N. Y., between certain well owners regarding the use of pumps brought out instructive evidence on the last point. At other places the need of a sensible policy of development and conservation that will look to future gains rather than to immediate profits is becoming apparent.

## VALUATION OF MINERAL WATER.

The same basis of valuation has been adopted in this report as was used in compiling the 1906 totals. It has been assumed that water has little intrinsic value, that the selling prices of most table and of many medicinal waters represent the cost of getting them to the consumer plus a charge sufficient to offset the uncertainties of trade and to give a reasonable profit. A hillside spring, clear and cool, may for years have been put to no more profitable use than watering stock, yet its water, if neatly bottled and attractively advertised, may be sold widely at an average price of 50 cents per gallon. The consumer in this case pays for bottles, labels, advertising, and labor, rather than for water. Hence the basis of valuation adopted is the average retail selling price at the spring, which includes the expense of getting the water ready for market, but excludes freight charges and other costs of distribution.

## REVIEW OF MINERAL-WATER TRADE IN 1907.

### OUTPUT AND VALUE.

The total reported output of mineral water in the United States in 1907 was 52,060,520 gallons, valued at $7,331,503, as against 48,108,580 gallons, valued at $8,026,387, in 1906. A comparison of the returns for the two years shows that there was a decline in output in 1907 from 14 of the States and Territories—Arkansas, Colorado, Connecticut, Florida, Iowa, Maine, New Hampshire, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, and Wisconsin—and an increase from 23—Alabama, California, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Rhode Island, Tennessee, Texas, Vermont, Virginia, Washington, and West Virginia.

A total of 584 springs reported sales, compared with 582 springs in 1906. The net increase in product amounted to 3,951,940 gallons, or more than 8 per cent; the loss in value of the output was, however, $696,884,[a] or nearly 9 per cent.

The following table gives a summary, by States, of the 1907 output. It shows the number of springs reporting sales, the number of gallons sold, the average retail price per gallon at the spring, the total value, and the value of the water sold for medicinal and for table use.

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[a] This loss is more apparent than real, as the water represented by it was largely used in the manufacture of beverages of various kinds, which have been excluded from the report for 1907.

*Production and value of mineral waters in the United States, 1907, by States.*

| State or Territory. | Number of springs reporting sales. | Quantity sold (gallons). | Average retail price per gallon at spring. | Value of medicinal waters. | Value of table waters. | Total value of mineral waters. |
|---|---|---|---|---|---|---|
| Alabama | 7 | 130,800 | $0.16 | $17,220 | $3,500 | $20,720 |
| Arkansas | 7 | 431,511 | .20 | 59,861 | 25,375 | 85,236 |
| California | 28 | 1,680,169 | .27 | 251,275 | 209,697 | 460,972 |
| Colorado | 12 | 775,100 | .20 | 45,775 | 108,640 | 154,415 |
| Connecticut | 13 | 307,906 | .18 | 4,470 | 36,969 | 41,439 |
| Florida | 7 | 43,430 | .29 | 9,669 | 2,709 | 12,378 |
| Georgia | 8 | 246,800 | .11 | 15,938 | 12,182 | 28,120 |
| Illinois | 15 | 720,400 | .13 | 31,240 | 60,520 | 91,760 |
| Indiana | 17 | 514,366 | .99 | 497,246 | 10,500 | 507,746 |
| Iowa | 6 | 127,200 | .24 | 23,633 | 6,867 | 30,500 |
| Kansas | 14 | 362,252 | .17 | 47,262 | 14,192 | 61,454 |
| Kentucky | 14 | 736,920 | .10 | 47,918 | 24,455 | 72,373 |
| Maine | 26 | 1,161,832 | .36 | 18,255 | 396,045 | 414,300 |
| Maryland | 7 | 1,023,562 | .11 | 20,200 | 89,839 | 110,039 |
| Massachusetts | 51 | 4,661,115 | .04 | 26,487 | 182,092 | 208,579 |
| Michigan | 19 | 1,472,679 | .09 | 35,091 | 92,042 | 127,133 |
| Minnesota | 8 | 9,654,030 | .05 | 7,088 | 517,712 | 524,800 |
| Mississippi | 8 | 425,500 | .22 | 85,055 | 8,295 | 93,350 |
| Missouri | 18 | 667,232 | .15 | 37,614 | 65,700 | 103,314 |
| New Hampshire | 6 | 343,500 | .48 | 53,015 | 111,928 | 164,943 |
| New Jersey | 11 | 982,445 | .11 | 9,600 | 93,482 | 103,082 |
| New Mexico | 4 | 65,800 | .14 | 4,170 | 4,950 | 9,120 |
| New York | 41 | 7,176,815 | .09 | 259,730 | 426,844 | 686,574 |
| North Carolina | 18 | 193,479 | .21 | 37,262 | 3,040 | 40,302 |
| Ohio | 24 | 1,536,621 | .08 | 33,777 | 87,754 | 121,531 |
| Oklahoma | 4 | 69,725 | .11 | 3,755 | 3,590 | 7,345 |
| Oregon | 5 | 24,225 | .23 | 2,369 | 3,187 | 5,556 |
| Pennsylvania | 27 | 1,287,063 | .18 | 75,418 | 160,389 | 235,807 |
| Rhode Island | 4 | 245,307 | .07 | 0 | 17,108 | 17,108 |
| South Carolina | 13 | 786,754 | .25 | 144,717 | 50,465 | 195,182 |
| Tennessee | 17 | 758,312 | .11 | 57,080 | 28,169 | 85,249 |
| Texas | 23 | 1,146,279 | .13 | 126,571 | 25,662 | 152,233 |
| Vermont | 7 | 88,550 | .23 | 8,055 | 11,893 | 19,948 |
| Virginia | 44 | 2,442,075 | .18 | 284,224 | 147,546 | 431,770 |
| Washington | 4 | 68,400 | .16 | 4,800 | 6,020 | 10,820 |
| West Virginia | 10 | 135,809 | .59 | 47,148 | 32,511 | 79,659 |
| Wisconsin | 29 | 6,839,219 | .22 | 482,392 | 1,044,311 | 1,526,703 |
| Other States and Territories[a] | 13 | 2,727,338 | .11 | 35,888 | 254,055 | 289,943 |
| Total | 584 | 52,060,520 | .15 | 2,951,268 | 4,380,235 | 7,331,503 |

[a] Includes Alaska, Arizona, Delaware, District of Columbia, Idaho, Louisiana, Montana, Nebraska, South Dakota, Utah, and Wyoming.

A comparison of the average prices per gallon in 1906 with those given by producers for 1907 shows that of the 37 States and Territories separately listed in the table of production there were 17 in which the average price per gallon varied 3 cents or less from the 1906 figures, 5 in which there were marked decreases, and 3 in which there were considerable increases. In the case of the State showing the greatest decrease the difference is due to the returns from one spring company, which admitted that the price reported for 1906 was excessive.

In the following table are shown the changes by States, including the number of springs reporting, the gains or losses in gallons sold and in value of output, and the percentage of decrease or increase in quantity and value:

*Comparative production of mineral waters, 1906–7.*

| State or Territory. | Increase (+) or decrease (−) in number of springs reporting sales. | Increase (+) or decrease (−) in gallons sold. | Percentage of increase (+) or decrease (−) in gallons sold. | Increase (+) or decrease (−) in value of product. | Percentage of increase (+) or decrease (−) in value of product. |
|---|---|---|---|---|---|
| Alabama | −2 | + 65,350 | +99.85 | − $5,355 | − 20.54 |
| Arkansas | −1 | − 296,254 | −40.71 | − 20,050 | − 19.04 |
| California | Same. | + 192,194 | +12.92 | − 59,543 | − 11.44 |
| Colorado | Same. | − 54,750 | − 6.60 | + 38,049 | + 32.70 |
| Connecticut | +4 | − 145,567 | −32.10 | − 35,388 | − 46.06 |
| Florida | +1 | − 28,064 | −39.25 | − 9,671 | − 43.86 |
| Georgia | Same. | + 115,900 | +88.54 | + 13,585 | + 93.46 |
| Illinois | Same. | + 145,947 | +25.41 | + 14,473 | + 18.73 |
| Indiana | −3 | + 49,378 | +10.62 | + 55,386 | + 12.24 |
| Iowa | +1 | − 100,300 | −44.08 | + 6,800 | + 28.69 |
| Kansas | +1 | + 56,295 | +18.40 | − 28,353 | − 31.57 |
| Kentucky | +2 | + 189,315 | +34.57 | − 3,768 | − 4.95 |
| Maine | −2 | − 206,281 | −15.07 | − 10,378 | − 2.44 |
| Maryland | +2 | + 429,891 | +72.41 | + 51,705 | + 88.64 |
| Massachusetts | −2 | + 803,160 | +20.81 | − 1,573 | − 0.75 |
| Michigan | Same. | + 570,151 | +63.17 | + 53,776 | + 73.31 |
| Minnesota | +1 | +1,032,051 | +11.97 | +349,123 | +198.73 |
| Mississippi | Same. | + 171,221 | +67.34 | + 40,530 | + 76.73 |
| Missouri | +1 | + 48,832 | + 7.90 | + 6,769 | + 7.01 |
| New Hampshire | +1 | − 438,000 | −56.05 | − 65,707 | − 28.49 |
| New Jersey | +2 | + 397,230 | +67.88 | + 37,896 | + 58.10 |
| New Mexico | −2 | − 28,200 | −30.00 | − 8,580 | − 48.47 |
| New York | −1 | + 695,741 | +10.73 | −206,902 | − 23.16 |
| North Carolina | Same. | + 37,127 | +23.75 | + 8,889 | + 28.30 |
| Ohio | −3 | − 254,146 | −14.19 | − 42,476 | − 25.90 |
| Oklahoma[a] | +1 | − 2,694 | − 3.72 | − 399 | − 5.15 |
| Oregon | −2 | − 6,625 | −21.47 | − 6,967 | − 55.63 |
| Pennsylvania | Same. | − 219,223 | −14.55 | − 44,247 | − 15.80 |
| Rhode Island | Same. | + 24,587 | +11.11 | + 947 | + 5.86 |
| South Carolina | +1 | − 671,740 | −46.06 | −153,562 | − 44.03 |
| Tennessee | +3 | + 346,614 | +84.19 | + 26,778 | + 45.80 |
| Texas | −5 | + 100,964 | + 9.66 | + 30,148 | + 24.69 |
| Vermont | +1 | + 11,050 | +14.26 | − 2,202 | − 9.94 |
| Virginia | +1 | + 444,868 | +22.27 | + 12,862 | + 3.07 |
| Washington | −2 | + 29,900 | +77.66 | + 20 | + 0.19 |
| West Virginia | Same. | + 12,929 | +10.52 | + 22,199 | + 33.63 |
| Wisconsin | +2 | − 863,499 | −11.21 | −870,991 | − 36.33 |
| States or Territories not included above[b] | +2 | +1,296,638 | +90.63 | +109,298 | + 60.50 |
| Net increase or decrease, 1907 | +2 | +3,951,940 | + 8.21 | −696,884 | − 8.68 |

[a] Comparison made with Indian Territory and Oklahoma combined in 1906.

[b] Alaska, Arizona, Delaware, District of Columbia, Idaho, Louisiana, Montana, Nebraska, South Dakota, Utah, and Wyoming.

This table shows that out of the twelve principal mineral-water producing States, those having an output of 1,000,000 gallons or more—California, Maine, Maryland, Massachusetts, Michigan, Minnesota, New York, Ohio, Pennsylvania, Texas, Virginia, and Wisconsin—there were three—Ohio, Pennsylvania, and Wisconsin—which produced less in 1907 than 1906. The causes of the apparent decline are noted in the discussion of trade by States.

In comparing the total output of this country in 1907 with the published totals for several previous years, allowance is to be made for the output credited then to delinquent springs—that is, springs which did not report production, but were assumed in the lack of any evidence to the contrary to be doing business. In this report no allowance is made for delinquents. The Survey's list of producers has been revised, repeated attempts have been made to get returns from those spring proprietors that were dilatory, and systematic effort has been made to get the names of all new springs. In addition, a great number of spring localities have been visited during the past few years by geologists connected with the Water Resources branch of the Survey, and the owners of all commercial springs in these localities have been asked for statements of output. Therefore it has been deemed best to restrict the totals given to returns actually received and to make no allowance for springs from which information is not available.

The following table shows the number of springs listed and the quantity and the value of the output reported from 1883 (when the Survey began to collect statistics of production) to 1907, inclusive:

*Estimated production of mineral waters, 1883–1907.*

| Year. | Number of springs. | Quantity sold (gallons). | Value. | Year. | Number of springs. | Quantity sold (gallons.) | Value. |
|---|---|---|---|---|---|---|---|
| 1883 | 189 | 7,529,423 | $1,119,603 | 1899 | 541 | 39,562,136 | $6,948,080 |
| 1884 | 189 | 10,215,328 | 1,459,143 | 1900 | 561 | a 45,276,995 | a 5,791,805 |
| 1885 | 224 | 9,148,401 | 1,312,845 | | | 47,558,784 | 6,245,172 |
| 1886 | 225 | 8,950,317 | 1,284,070 | 1901 | 659 | a 54,733,661 | a 7,443,904 |
| 1887 | 215 | 8,259,609 | 1,261,463 | | | 55,771,188 | 7,586,962 |
| 1888 | 198 | 9,578,648 | 1,679,302 | 1902 | 721 | a 63,174,552 | a 8,634,179 |
| 1889 | 258 | 12,780,471 | 1,748,458 | | | 64,859,451 | 8,798,761 |
| 1890 | 273 | 13,907,418 | 2,600,750 | 1903 | 725 | a 40,107,147 | a 6,788,426 |
| 1891 | 288 | 18,392,732 | 2,996,259 | | | 51,242,757 | 9,041,078 |
| 1892 | 283 | 21,876,604 | 4,905,970 | 1904 | 738 | a 41,969,145 | a 6,218,873 |
| 1893 | 330 | 23,544,495 | 4,246,734 | | | b 50,723,500 | b 7,198,450 |
| 1894 | 357 | 21,569,608 | 3,741,846 | 1905 | 731 | a 46,544,361 | a 6,491,251 |
| 1895 | 370 | 21,463,543 | 4,254,337 | | | 47,590,081 | 6,811,611 |
| 1896 | 377 | 25,795,312 | 4,136,192 | 1906 | c 582 | a 48,108,580 | a 8,028,387 |
| 1897 | 441 | 23,256,911 | 4,599,106 | 1907 | c 584 | 52,060,520 | 7,331,508 |
| 1898 | 484 | 28,853,464 | 8,051,833 | | | | |

[a] Quantity actually reported.

[b] Excludes 14,995,000 gallons, valued at $3,000,000, turned into public supplies, but included in original estimate for 1904, and 2,000,000 gallons, valued at $200,000, used otherwise than as mineral water.

[c] Springs reporting sales.

## CARBONATED BEVERAGES.

The present importance of the trade in carbonated sweetened beverages, in making which much spring or well water is used, is shown by the following figures compiled from actual returns. The figures are noteworthy because they refer largely to the high-grade beverages of this class, the cheaper grades being made from town supplies or from waters not considered good enough to be sold as water. The total output of such beverages reported from springs included in this or the 1906 list of producers amounted in 1907 to 5,255,535 gallons, and the water used in their manufacture had a nominal total value of $303,115. The figures from the eight States making the largest showing are appended:

*Mineral water used in making soft drinks, 1907, in gallons.*

| State. | Quantity. | Value. | State. | Quantity. | Value. |
|---|---|---|---|---|---|
| Wisconsin | 1,340,600 | $82,805 | Ohio | 256,500 | $10,225 |
| Massachusetts | 987,940 | 13,440 | South Carolina | 237,420 | 16,530 |
| Michigan | 640,000 | 32,000 | Pennsylvania | 221,620 | 12,530 |
| Maine | 352,080 | 13,690 | Louisiana | 220,000 | 9,050 |

## TRADE BY STATES.

A comparative statement of the number of springs reporting sales and the quantity and value of the output by States for 1906 and 1907 are given in the accompanying table:

*Number of springs and quantity and value of mineral waters sold in 1906 and 1907.*

| State or Territory. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Springs reporting. | Quantity sold (gallons). | Value. | Springs reporting. | Quantity sold (gallons). | Value. |
| Alabama | 9 | 65,450 | $26,075 | 7 | 130,800 | $20,720 |
| Alaska | 1 | | | 1 | | |
| Arizona | 1 | | | 1 | | |
| Arkansas | 8 | 727,765 | 105,286 | 7 | 431,511 | 85,236 |
| California | 28 | 1,487,975 | 520,515 | 28 | 1,680,169 | 460,972 |
| Colorado | 12 | 829,850 | 116,366 | 12 | 775,100 | 154,415 |
| Connecticut | 9 | 453,473 | 76,827 | 18 | 307,906 | 41,439 |
| Delaware | 0 | | | 1 | | |
| District of Columbia | 1 | | | 1 | | |
| Florida | 6 | 71,494 | 22,049 | 7 | 43,430 | 12,378 |
| Georgia | 8 | 130,900 | 14,535 | 8 | 246,800 | 28,120 |
| Idaho | 1 | | | 1 | | |
| Illinois | 15 | 574,453 | 77,287 | 15 | 720,400 | 91,760 |
| Indiana | 20 | 464,988 | 452,360 | 17 | 514,366 | 507,746 |
| Iowa | 5 | 227,500 | 23,700 | 6 | 127,200 | 30,500 |
| Kansas | 13 | 305,957 | 89,807 | 14 | 362,252 | 61,454 |
| Kentucky | 12 | 547,605 | 76,141 | 14 | 736,920 | 72,873 |
| Louisiana | 1 | | | 2 | | |
| Maine | 28 | 1,368,113 | 424,678 | 26 | 1,161,832 | 414,300 |
| Maryland | 5 | 593,671 | 58,334 | 7 | 1,023,562 | 110,089 |
| Massachusetts | 53 | 3,857,955 | 210,152 | 51 | 4,661,115 | 208,579 |
| Michigan | 19 | 902,528 | 73,357 | 19 | 1,472,679 | 127,133 |
| Minnesota | 7 | 8,621,979 | 175,677 | 8 | 9,654,030 | 524,800 |
| Mississippi | 8 | 254,279 | 52,820 | 8 | 425,500 | 93,350 |
| Missouri | 17 | 618,400 | 96,545 | 18 | 667,232 | 103,314 |
| Montana | 1 | | | 2 | | |
| Nebraska | 1 | | | 1 | | |
| New Hampshire | 5 | 781,500 | 230,650 | 6 | 343,500 | 164,243 |
| New Jersey | 9 | 585,215 | 65,186 | 11 | 982,445 | 103,082 |
| New Mexico | 6 | 94,000 | 17,700 | 4 | 65,800 | 9,120 |
| New York | 42 | 6,481,074 | 893,476 | 41 | 7,176,815 | 686,574 |
| North Carolina | 13 | 156,352 | 31,413 | 13 | 193,479 | 40,302 |
| North Dakota | 1 | | | 0 | | |
| Ohio | 27 | 1,790,767 | 164,007 | 24 | 1,536,621 | 121,581 |
| Oklahoma | 3 | [a]72,419 | [a]7,744 | 4 | 69,725 | 7,345 |
| Oregon | 7 | 30,850 | 12,523 | 5 | 24,225 | 5,556 |
| Pennsylvania | 27 | 1,506,286 | 280,054 | 27 | 1,287,063 | 235,807 |
| Rhode Island | 4 | 220,770 | 16,161 | 4 | 245,307 | 17,108 |
| South Carolina | 12 | 1,458,494 | 348,744 | 13 | 786,754 | 195,182 |
| South Dakota | 1 | | | 1 | | |
| Tennessee | 14 | 411,698 | 58,471 | 17 | 758,312 | 85,249 |
| Texas | 28 | 1,045,315 | 122,085 | 23 | 1,146,279 | 152,233 |
| Utah | 1 | | | 1 | | |
| Vermont | 6 | 77,500 | 22,150 | 7 | 88,550 | 19,948 |
| Virginia | 43 | 1,997,207 | 418,908 | 44 | 2,442,075 | 431,770 |
| Washington | 6 | 38,500 | 10,800 | 4 | 68,400 | 10,820 |
| West Virginia | 10 | 122,880 | 57,460 | 10 | 135,809 | 79,659 |
| Wisconsin | 27 | 7,702,718 | 2,397,694 | 29 | 6,839,219 | 1,526,703 |
| Wyoming | 1 | | | 1 | | |
| States or Territories of one or two springs each, including those for which figures are not given in the above list | | 1,430,700 | 180,650 | | 2,727,338 | 289,943 |
| Total | 582 | 48,108,580 | 8,028,387 | 584 | 52,060,520 | 7,331,503 |

[a] Includes production of Indian Territory in 1906.

The condition of trade in each State, the causes for the gains or losses shown, the use of springs as resorts, and the list of springs in each State from which returns of sales are available, are summarized in the following pages.

### ALABAMA.

The output of mineral waters in Alabama during 1907 amounted to 130,800 gallons, valued at $20,720, a gain of 65,350 in quantity, and a decrease in value of $5,355. The average retail price per gallon was $0.16, as against $0.40 in 1906. One new spring reported—the Livingston. The number of springs reporting sales is 2 less than in 1906. The decrease in value of product is explained by the great decline in production of the spring obtaining the highest price for its water. By far the larger part of the output is used for medicinal purposes. Four of the 7 springs reporting sales are the sites of resorts, with accommodations for more than 800 people, and the water at 3 of them is said to be used for bathing.

Those reporting sales are as follows:

Bailey Springs, Florence, Lauderdale County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Wells, near Ohatchee, Calhoun County.
Livingston Mineral Springs, Livingston, Sumter County.
MacGregor Spring, Spring Hill, Mobile County.
Wilkinson's Matchless Mineral Wells, east of Greenville, Butler County.
York Well, York, Sumter County.

### ALASKA.

No addition was made to the list of springs in Alaska for 1907, the same spring reporting as in 1906. This spring changed hands during 1907 and expects to do a much larger business the forthcoming year. As yet all of the water is used for table purposes. The name of the spring follows:

Zarembo Mineral Spring, Zarembo Island.

### ARIZONA.

But one spring in Arizona reported to the Survey sales of water during 1907. The spring is a resort with a capacity of 150 guests, the water being used principally at the hotel for table and medicinal purposes, but also for bathing. This spring is:

Castle Hot Springs, Hot Springs, Yavapai County.

### ARKANSAS.

The returns for Arkansas for 1907 showed a decided decrease in both the quantity and value of the output, the sales decreasing from 727,765 gallons, valued at $105,286, in 1906, to 431,511 gallons, valued at $85,236, in 1907, a decrease of 296,254 gallons in quantity and of $20,050 in value. The average retail price per gallon at the spring was $0.20. This decrease was largely due to unfavorable weather in April, May, and June, which kept down the attendance at resorts. The number of springs reporting sales was one less than in 1906, though one new spring reported, the Eureka. There are hotels at 4 springs, with accommodations for more than 1,500 people, where the water is used for bathing. About two-thirds of the output is classed as medicinal water. The 7 springs to report sales are:

Arkansas Lithia Springs, near Hope, Hempstead County.
Arsenic Springs, Hot Springs, Garland County.
Eureka Springs, Eureka Springs, Carroll County.

Howard's Mineral Wells, Sharp, Independence County.
Mountain Valley Spring, near Hot Springs, Garland County.
Ozarka Springs, Eureka Springs, Carroll County.
Potash Sulphur Springs, Lawrence, Garland County.

### CALIFORNIA.

In spite of predictions to the contrary, the returns for California for 1907 showed an increase in gallons sold, though the value decreased somewhat. Both production and value would be higher were water used in making soft drinks included. The actual output reported was 1,680,169 gallons, valued at $460,972, an increase in quantity of 192,194 gallons and a decrease in value of $59,543 from the 1906 figures. Five new springs reported—the Console, Duncan, El Granito, Ferndale, and Tahoe. Two springs were excluded which have previously been listed, as they stated their entire production was used for the manufacture of soft drinks. The number reporting sales was the same as in 1906. The record for the past five years is as follows:

*Production and value of mineral waters in California, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 34 | 1,862,855 | $706,372 | 1906 | 28 | 1,487,975 | $520,515 |
| 1904 | 35 | 3,756,779 | 899,763 | 1907 | 28 | 1,680,169 | 460,972 |
| 1905 | 39 | 1,934,784 | 675,214 | | | | |

A little more than one-half the entire output is used for medicinal purposes. Eighteen of the springs are the sites of resorts, with aggregate accommodations for 2,540 people, and the water at 11 is used for bathing. There are 28 springs reporting sales.

Ætna Spring, Pope Valley, Napa County.
Alhambra Spring, near Martinez, Contra Costa County.
Bradley Spring, near Foster, San Diego County.
Buckman Springs, near Descanso, San Diego County.
California Geysers, Sonoma County.
Castalian Spring, Inyo County.
Castle Rock Spring, Castle Rock, Shasta County.
Club House Spring, Sausalito, Marin County.
Console Mineral Spring, Riverside County.
Cooks Springs, near Williams, Colusa County.
Duncan Springs, Hopland, Mendocino County.
Ferndale Mineral Springs, near Martinez, Contra Costa County.
El Granito Mineral Spring, El Cajon, San Diego County.
Iron Lithia Spring, Eden Hot Springs, Riverside County.
Isham Springs, near San Diego, San Diego County.
Lepori's Vichy Springs, near Napa, Napa County.
Lytton Spring, Lytton, Sonoma County.
McDowell Spring, Hopland, Mendocino County.
Mount Ida Mineral Spring, Wyandotte, Butte County.
Napa Soda Springs, Napa Valley, Napa County.
Pacific Congress Spring, Saratoga, Santa Clara County.
San Benito Spring, near Hollister, San Benito County.
Shasta Spring, Shasta Springs, Siskiyou County.
Tahoe Mineral Spring, near Truckee, Placer County.
Tassajara Hot Springs, Monterey County.
Upper Soda Spring, near Dunsmuir, Siskiyou County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
White Sulphur Spring, Eden Hot Springs, Riverside County.
Witter Medical Spring, Witter Springs, Lake County.

## COLORADO.

The production of mineral waters in Colorado in 1907 amounted to 775,100 gallons, valued at $154,415, as against 829,850 gallons, valued at $116,366 in 1906, a decrease in quantity of 54,750 gallons and an increase in value of $38,049. The lessened output is accounted for by water used in making ginger ale and other carbonated beverages. The average retail price per gallon at the spring was $0.20. About two-thirds of the total production was used as table water. One new spring reported, the Calsic, but the total number reporting was the same as 1906. Five of the springs are said to be used as resorts, with accommodations for over 5,000 people, and the water at 4 is used for bathing purposes. The 12 springs making returns of sales are as follows:

Blue Ribbon Mineral Spring, Idaho Springs, Clear Creek County.
Boulder Springs, Boulder Springs, Boulder County.
Calsic Mineral Spring, Colorado Springs, El Paso County.
Canon City Vichy Spring, Canon City, Fremont County.
Clark Magnetic Mineral Spring, Pueblo, Pueblò County.
Columbia Mineral Spring, Denver, Denver County.
Golden Lithia Spring, near Golden, Jefferson County.
Navaho, Shoshone, Manitou, and Cheyenne Springs, Manitou, El Paso County.
Pueblo Magnetic Mineral Spring, South Pueblo, Pueblo County.
Ute Chief Spring, Manitou, El Paso County.
Ute Iron, Ouray, and Little Chief Springs, Manitou, El Paso County.
Yampah Spring, Glenwood Springs, Garfield County.

## CONNECTICUT.

The returns for Connecticut in 1907 show sales of mineral waters to the amount of 307,906 gallons, valued at $41,439, a decrease of 145,567 gallons in quantity and of $35,388 in value. This decrease is partly explained by the exclusion of water used for the manufacture of soft drinks, but is apparently chiefly due to the fact that the improved quality of the water furnished by several town supply systems has lessened the demand for other drinking water. There were 5 new springs reporting, the Elco, Highland, Hillside, Red Rock, and Rock Ledge, making the total number 4 more than in 1906. About nine-tenths of the production is sold for table purposes, at an average retail price per gallon of $0.13. There are no springs used as resorts in this State. The list of those springs reporting sales follows:

Arethusa Spring, Seymour, New Haven County.
Cherry Hill Spring, Highwood, New Haven County.
Elco Springs, Bristol, Hartford County.
Granite Rock Spring, Higganum, Middlesex County.
Highland Spring, near Mount Higbee, Middlesex County.
Hillside Spring, Meriden, New Haven County.
Live Oak Spring, Meriden, New Haven County.
Mohican Springs, Fairfield, Fairfield County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Red Rock Spring, Meriden, New Haven County.
Rock Ledge Spring, New Haven, New Haven County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Varuna Spring, Stamford, Fairfield County.

## DELAWARE.

Delaware entered the list of mineral-water producers for the first time in 1907, one spring reporting a large output. The water so far is used entirely for table purposes. This spring is:

Kiamensi Spring, near Wilmington, Newcastle County.

## DISTRICT OF COLUMBIA.

There was no change in the list of mineral-water producers in the District of Columbia during 1907, the same spring reporting sales as heretofore. The water from this spring is used entirely for table purposes. The returns show an increase in output, but, in accordance with the custom of the Survey, this production is included with other States having less than three producers. The name of the spring is:

Gitche Crystal Spring, Benning.

## FLORIDA.

The sales of mineral waters in Florida continued to show a decline during 1907. The reported production was 43,430 gallons, valued at $12,378, as against 71,494 gallons, valued at $22,049, in 1906, a decrease of 28,064 gallons in quantity and of $9,671 in value. It is probable that this decrease indicates more water given away, as most of the springs are used as resorts, and the managers in nearly every case report a prosperous season. About three-fourths of the entire production is used for medicinal purposes. The average retail price per gallon at the spring was $0.29. Two new springs reported, the Dishong and the Quisiance, making the total number giving sales 1 more than last year. Resorts are situated at 6 of the springs, with accommodations for 800 people, and at the same 6 springs the waters are used for bathing purposes. The 7 springs making returns of sales are:

Dishong Spring, Tampa, Hillsboro County.
Espiritu Santo Spring, Tampa Bay, Hillsboro County.
Hampton Springs, Hampton Springs, Taylor County.
Magnolia Spring, Magnolia Springs, Clay County.
Orange City Mineral Spring, Orange City, Volusia County.
Quisiance Spring, Green Cove Springs, Clay County.
Suwanee Sulphur Springs, Suwanee, Suwanee County.

## GEORGIA.

The returns from Georgia show much larger sales of mineral waters in 1907 than in 1906. The actual figures reported are 246,800 gallons, valued at $28,120, a gain of 115,900 gallons in quantity and of $13,585 in value over the 1906 production of 130,900 gallons, valued at $14,535. Two new springs were added to the list, the Benscot Lithia and Miller's springs, the total number reporting sales being the same as for 1906. The production of these two new springs accounts in part for the greatly increased sales, one of them having taken over several smaller springs. A little more than half of the entire output is used for medicinal purposes. The average retail price per gallon at the spring was $0.11, the same as for 1906. Four of the springs are said to be the sites of resorts with a capacity of over 700 people, and the water at 2 is used for bathing purposes. Following is the list of producers reporting sales:

Artesian Lithia Well, Austell, Cobb County.
Benscot Lithia Springs, Austell, Cobb County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Cox Mineral Spring, Waynesboro, Burke County.
Hughes's Mineral Spring, Rome, Floyd County.
Louch Lithium Well, Austell, Cobb County.
Major's Springs, Menlo, Chatooga County.
Miller's Spring, Milledgeville, Baldwin County.

### IDAHO.

There was no change in Idaho's list of mineral water producers, the same spring reporting as in previous years. About one-fifth of the water of this spring is sold for medicinal purposes, and the remainder for table use. The spring is a resort. It is:

Idanha Spring, Soda Springs, Bannock County.

### ILLINOIS.

The mineral water trade in Illinois continued to increase during 1907, the returns showing an increase of 25 per cent in quantity sold and of nearly 20 per cent in value. The actual figures reported are 720,400 gallons sold, valued at $91,760, which, compared with the 1906 returns of 574,453 gallons, valued at $77,287, show increases of 145,947 gallons in quantity and of $14,473 in value. The gains would be much greater were water used in making soft drinks included in the 1907 totals. The average retail price for the year was $0.13. About one-third of the sales was water for medicinal purposes. Two new springs reported for the first time in 1907, the Peoria and the White Eagle, the total number reporting being the same as for 1906. There are 4 resorts, situated at as many springs, accommodating 110 people, and the water at 3 of them is said to be used for bathing purposes. The list of reporting springs follows:

Abana Mineral Springs, Libertyville, Lake County.
Aqua Vitae Mineral Spring, Maquon, Knox County.
Deer Lick Mineral Spring, Deerfield, Lake County.
Depler Mineral Spring, near Lewistown, Fulton County.
Diamond Mineral Springs, near Grantfork, Madison County.
Gravel Springs, near Jacksonville, Morgan County.
Greenup Mineral Spring, Greenup, Cumberland County.
Iron Magnesia Spring, Pike County.
Libertyville Crystal Spring, Libertyville, Lake County.
Macinac Mineral Spring, near Carlock, McLean County.
Mokena Mineral Spring, near Mokena, Will County.
Peoria Mineral Springs, Peoria, Peoria County.
Sanicula Spring, Ottawa, La Salle County.
White Diamond Spring, South Elgin, Kane County.
White Eagle Spring, Edgemont, St. Clair County.

### INDIANA.

There was prosperity in the mineral water trade of Indiana during 1907, the gain in sales amounting to 49,378 gallons, or 10 per cent, and the value increasing in even greater proportion. According to reports received from producers the quantity of water sold was 514,-

366 gallons, valued at $507,746, the average retail price being $0.99. About 2 per cent of the total is used as table water, the remainder being used for medicinal purposes. No new springs reported during 1907, the total number being 3 less than in 1906. Resorts are situated at 5 of the springs, and the water at 7 is said to be used for bathing. Those reporting sales are:

Blue Cast Magnetic Spring, Woodburn, Allen County.
Cartersburg Mineral Spring, Cartersburg, Hendricks County.
Coats Springs, Logan Township, Pike County.
Colomagna Spring, Columbus, Bartholomew County.
Kickapoo Magnetic Spring, Warren Township, Warren County.
King's Mineral Spring, Dallas, Clarke County.
La Salle Spring, Martin County.
Laxine Spring, Mount Moriah, Brown County.
McCullough Spring, Oakland City, Gibson County.
Mineral Spa Lithia Spring, near Richmond, Wayne County.
Mudlavia Lithia Spring, Kramer, Warren County.
Mudlavia Sulphur Spring, Kramer, Warren County.
Paoli Lithia Spring, Paoli, Orange County.
Pluto, Proserpine and Bowles Springs, French Lick, Orange County.
Terre Haute Artesian Mineral Spring, Terre Haute, Vigo County.
West Baden Mineral Springs, West Baden, Orange County.
White Crane Mineral Well, Dillsboro, Dearborn County.

## IOWA.

The mineral-water trade of Iowa showed further decline in 1907, every spring reporting either a decrease or the same production as in 1906. One new spring was added to the list, the White Sulphur. According to the producers' returns, the quantity sold was 127,200 gallons, valued at $30,500, a decrease of 100,300 gallons from the 1906 output of 227,500, and an increase in value of $6,800, as compared with the 1906 value of $23,700. The average retail price at the spring for 1907 was $0.24. It is possible that some decreases in sales are due to less advertising, but the extensive use of artesian well water by the public doubtless affects trade. The total number of springs reporting sales is increased by 1. At 2 of the springs are resorts, and the water at 3 is used for bathing. Those springs for which returns are available are as follows:

Colfax Spring, Colfax, Jasper County.
Heston's Springs, Fairfield, Jefferson County.
Lineville Spring, Lineville, Wayne County.
Ottumwa Mineral Spring, Ottumwa, Wapello County.
Red Mineral Spring, near Eddyville, Wapello County.
White Sulphur Spring, Linnwood, Scott County.

## KANSAS.

Returns from Kansas show a gain in the sales of mineral waters, the output increasing from 305,957 gallons in 1906 to 362,252 gallons in 1907, a gain of 56,295, or 18 per cent. This gain is largely due to energetic exploitation, since a considerable quantity of water used in making soft drinks was included in the 1906 returns. The value, however, decreased over 30 per cent, or from $89,807 in 1906 to $61,454 in 1907, the average retail price for 1907 being $0.17, as against $0.29 reported in 1906. Two new springs reported for the first time in 1907, the Aganippe and the Crystal, making the total number reporting sales greater by 1. Seven of the springs are used as resorts, and have accommodations for over 800 people, and the water at 7 is used for bathing purposes. About three-fourths of the entire output is sold for medicinal use. The springs from which reports were received are:

AbilenA Spring, Willowdale Township, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Blasing's Natural Medical Spring, near Manhattan, Riley County.
Boon Vichy Spring, Topeka, Shawnee County.
California Spring, Franklin County.
Chautauqua Mineral Springs, Chautauqua, Chautuaqua County.
Crystal Spring, Coffeyville, Montgomery County.
Geuda Springs, Cowley County.
Henry Hoover Spring, Onaga, Pottawatomie County.
Merrill Spring, Carbondale, Osage County.
Phillip's Mineral Spring, Topeka, Shawnee County.
Sun Mineral Spring, Morrill, Brown County.
Sycamore Mineral Spring, Brown County.
Waconda Spring, near Cawker City, Mitchell County.

## KENTUCKY.

According to reports received from producers the mineral water trade of Kentucky is steadily increasing. The 1907 totals show a gain in sales of 189,315 gallons, or 34 per cent, over 1906, the gain being attributed largely to improvements made at resorts and to better facilities for marketing water. The value decreased slightly, however, due to lower retail prices being quoted. The reported output was 736,920 gallons, valued at $72,373, an average of about $0.10 per gallon. About two-thirds of Kentucky's mineral water is used for medicinal purposes. One new producer was added to the list—the Robson—the total number reporting being 14, or 2 more than for 1906. Resorts are situated at 4 of the springs and the water at 4 is used for bathing purposes. The 14 producers to report sales are:

Anita Springs, La Grange, Oldham County.
Beechwood Springs, Beechwood, Owen County.
Big Bone Spring, Big Bone, Boone County.
Blue Lick Spring, Blue Lick Springs, Nicholas County.
Drennon Springs, Henry County.
Glen Lily Spring, near Bowling Green, Warren County.
Hamby's Salts, Iron and Lithia Springs, Dawson Springs, Hopkins County.
Lexington Lithia Springs, Lexington, Fayette County.
Renfro White Sulphur Spring, Lexington, Fayette County.
Robson Spring, Alexandria Pike, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
Smith Medical Well, near Kelly, Christian County.
Upper Blue Lick Spring, Davidson, Nicholas County.
White's Crab Orchard Spring, Crab Orchard, Lincoln County.

## LOUISIANA.

Louisiana shows a great gain in the sales of mineral waters for 1907, the result in part of a new spring reporting and of the activity of another in pushing sales. The rate of increase over 1906 was about 145 per cent. One of the springs is used as a resort, but at neither is the water used for bathing. The 2 springs that made returns are:

Abita Springs, Abita Springs, St. Tammany Parish.
Krotz Spring, Krotz Springs, St. Landry Parish.

## MAINE.

The returns from Maine indicate a decrease in 1907 as to both quantity and value of the mineral water output. According to returns received, the production was 1,161,832 gallons, valued at $414,300, while the production for 1906 was 1,368,113 gallons, valued at $424,678, a decrease of 206,281 gallons and of $10,378. The average retail price per gallon was $0.36 in 1907. Various reasons are given for the decrease, probably the most important being a large deduction of water used for soft drinks, one spring which previously reported a large output being omitted entirely. A cool summer also caused less demand for spring water, and at several of the towns the public supply has been purified. The proprietors of 4 springs reporting sales in 1906 state that water was given away in 1907, and a few others were inactive during the year. Two new springs were heard from, the Glenwood and the Mount Kebo, the total number reporting sales being 26, a decrease of 2 from 1906. The record of production for the last five years is as follows:

*Production and value of mineral waters in Maine, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 24 | 612,381 | $92,714 | 1906 | 28 | 1,368,113 | $424,678 |
| 1904 | 23 | 1,535,955 | 428,083 | 1907 | 26 | 1,161,832 | 414,300 |
| 905 | 29 | 1,167,787 | 246,159 | | | | |

About 4 per cent of the 1907 output reported was sold for medicinal purposes, the bulk going for table use. There are resorts at 5 of the springs, with accommodations for 650 people, and the water at 2 is said to be used for bathing.

Those springs reporting sales are as follows:

Bakers Puritan Spring, Old Orchard, York County.
Carrabassett Mineral Spring, Carrabassett, Franklin County.
Crystal Mineral Spring, Auburn, Androscoggin County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Mineral Spring, Greene, Androscoggin County.
Glenwood Spring, Auburn, Androscoggin County.
Glenwood Spring, St. Albans, Somerset County.
Highland Spring, Lewiston, Androscoggin County.
Indian Hermit Spring, Wells, York County.
Katagudos Spring, Eastbrook, Hancock County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Mount Kebo Spring, Bar Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Pejepscot Spring, Auburn, Androscoggin County.
Poland Spring, Poland, Androscoggin County.
Pownal Mineral Spring, New Gloucester, Cumberland County.
Raymond Spring, North Raymond, Cumberland County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Wales, Androscoggin County.
Seal Rock Spring, Saco, York County.
Switzer Spring, Prospect, Waldo County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Ticonic Mineral Spring, Winslow, Kennebec County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Wawa Lithia Spring, Ogunquit, York County.
Windsor Mineral Spring, Lewiston, Androscoggin County.

## MARYLAND.

Maryland returns show a large increase in the sales of mineral waters in 1907 as compared with 1906, the gain in output being 429,891 gallons, or 72 per cent. The value also increased from $58,334 in 1906 to $110,039 in 1907, a gain of $51,705, or 88 per cent. The average retail price per gallon was $0.11. Two new springs entered the list, the Blue Ridge and the White Rock Mountain, making a total of 7. One of these, close to the State line, was formerly included with the Pennsylvania returns. All the springs did a good business, only 1 showing a decrease in sales. The record of the State for the last five years has been as follows:

*Production and value of mineral waters in Maryland, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 9 | 511,940 | $45,918 | 1906 | 5 | 593,671 | $58,334 |
| 1904 | 5 | 416,200 | 44,320 | 1907 | 7 | 1,023,562 | 110,039 |
| 1905 | 5 | 456,214 | 44,627 | | | | |

About one-fifth of the total output is sold for medicinal purposes, the remainder being classed as table water. Resorts are situated at 4 of the springs with accommodations for more than 300 people, and the water at 2 of them is said to be used for bathing purposes. Those reporting sales are as follows:

Altamont Spring, near Deer Park, Garrett County.
Blue Ridge Spring, Blue Mountain, Washington County.
Carroll Spring, Forest Glen, Montgomery County.
Chattolanee Spring, Chattolanee, Baltimore County.
Mardela Spring, Mardela, Wicomico County.
Takoma Spring, Takoma Park, Montgomery County.
White Rock Mountain Spring, Blue Mountain, Washington County.

## MASSACHUSETTS.

Returns from Massachusetts indicate a very prosperous year in the mineral water trade, in spite of the exclusion from the returns of a large quantity of water used in the manufacture of ginger ale, etc. The figures reported are 4,661,115 gallons, valued at $208,579, as against 3,857,955 gallons, valued at $210,152, in 1906, a gain in quantity of 803,160 gallons and a decrease in value of $1,573. Poor quality of public service supplies and efforts to get trade are among the causes given for gains. The average retail price per gallon for 1907 was $0.04. This relatively low price per gallon is explained by the fact that much of the Massachusetts water is sold in barrels to factories for drinking purposes at a certain price per week or per month, and consequently commands a smaller price than that sold in bottles and shipped some distance to markets. No new springs reported during 1907. Three springs which have previously reported sales to the Survey were omitted this year, as all of their output goes into the manufacture of soft drinks, and 1 failed to reply to the inquiries sent. The total number reporting sales was 51. The record for the last five years has been as follows:

*Production and value of mineral waters in Massachusetts, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 64 | 5,931,262 | $243,671 | 1906 | 53 | 3,857,955 | $210,152 |
| 1904 | 56 | 5,214,068 | 353,485 | 1907 | 51 | 4,661,115 | 208,579 |
| 1905 | 59 | 4,202,263 | 208,419 | | | | |

Less than one-fifth of the water is used for medicinal purposes. Resorts are situated at 4 of the springs, with accommodations for 139 people, and the water at 1 is said to be used for bathing. The 51 reporting springs are:

Abbotts Spring, Methuen, Essex County.
Ballardvale Spring, Andover, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Belmont Natural Spring, Belmont, Middlesex County.
Burnham Spring, Methuen, Essex County.
Chapmans Crystal Mineral Spring, Stoneham, Middlesex County.
Crescent Spring, Brockton, Plymouth County.
Diamond Spring, Lawrence, Essex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington Silver Spring, Milton, Norfolk County.
Fulton Natural Spring, Medford, Middlesex County.
Garfield Spring, Weymouth, Norfolk County.
Geddes Mineral Spring, Marlboro, Middlesex County.
Granite Rock Spring, Brockton, Plymouth County.
Highland Spring, West Abington, Plymouth County.
Hillcrest Spring, Rowley, Essex County.
Indian Spring, Brockton, Plymouth County.
Katahdin Spring, Lexington, Middlesex County.
King Philip Spring, Mattapoisett, Plymouth County.
Leland Spring, Natick, Middlesex County.
Lovers Leap Spring, West Lynn, Essex County.
Lovers Leap Deep Glen Spring, West Lynn, Essex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Monatiquot Spring, South Braintree, Norfolk County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Middlesex, Middlesex County.
Nemasket Spring, Middleboro, Plymouth County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.
Oak Grove Spring, Lawrence, Essex County.
Pearl Hill Mineral Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pocahontas Spring, Lynnfield Center, Essex County.
Purity Spring, Spencer, Worcester County.
Ravenwood Spring, Gloucester, Essex County.
Robbins Springs, Arlington Heights, Middlesex County.
Rock Spring, Newburyport, Essex County.
Sager Spring, Whipple Hill, Essex County.
Sand Springs, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Silver Seal Spring, Woburn, Middlesex County.
Simpson Spring, South Easton, Bristol County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Sunnyside Spring, Franklin, Norfolk County.
Swampscott Spring, Swampscott, Essex County.
Trapelo Spring, Belmont, Middlesex County.

**Undine Crystal Spring, Brighton, Suffolk County.**
**Valpey Spring, Lawrence, Essex County.**
**Whitman Spring, Whitman, Plymouth County.**

## MICHIGAN.

There was a notable increase in the mineral-water trade of Michigan during 1907, though the sales did not reach by far the production reported in 1905 of 2,684,800 gallons, in which, however, was included water used for ginger ale, etc. The figures for 1907 are 1,472,679 gallons, valued at $127,133, indicating an increase of 570,151 gallons, or 63 per cent, and of $53,776, or 73 per cent, over the 1906 production of 902,528 gallons, valued at $73,257. The average retail price per gallon at the spring in 1907 was $0.09. Three springs which reported sales in 1906 were omitted in 1907 as their water was used for soft drinks or was furnished free to guests at resorts. Five new springs reported for the first time—the Battle Creek, Crystal, Davis, Royal Oak Lithia, and White Oak—making the total number reporting the same as in 1906. The record of the output and value of Michigan's mineral water for the last five years is as follows:

*Production and value of mineral waters in Michigan 1903–7.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 19 | 6,919,107 | $200,668 | 1906 | 19 | 902,528 | $73,357 |
| 1904 | 19 | 3,385,675 | 118,422 | 1907 | 19 | 1,472,679 | 127,133 |
| 1905 | 17 | 2,684,800 | 277,188 | | | | |

About one-third of the State's total output is used for medicinal purposes, the remainder being table water. Resorts are situated at 6 of the springs, with accommodations for 880 people, and the water at 4 of them is said to be used for bathing purposes. The 19 producers reporting sales are as follows:

**Andrews Magnetic Mineral Spring, St. Louis, Gratiot County.**
**Battle Creek Lithia Spring, Battle Creek, Calhoun County.**
**Bromo-Hygeia Mineral Well, Coldwater, Branch County.**
**Crystal Springs, Grand Rapids, Kent County.**
**Davis Springs, Topinabee, Cheboygan County.**
**Lansingwald Spring, Grand Rapids, Kent County.**
**Midland Mineral Spring, Midland, Midland County.**
**No-che-mo Mineral Spring, Reed City, Osceola County.**
**Ogemaw Spring, Maltby, Ogemaw County.**
**Pagoda Spring, Mount Clemens, Macomb County.**
**Ponce de Leon Spring, Paris Township, Kent County.**
**Prosit Flowing Well, Flint, Genesee County.**
**Royal Oak Lithia Spring, Royal Oak, Oakland County.**
**Salutaris Spring, St. Clair, St. Clair County.**
**Sanitas Spring, Topinabee, Cheboygan County.**
**Sterling Spring, Crystal Falls, Iron County.**
**Victory Spring, Mount Clemens, Macomb County.**
**White Oak Spring, near Battle Creek, Calhoun County.**
**Yo-Landa Spring, Big Rapids, Mecosta County.**

## MINNESOTA.

Minnesota continues to occupy first place in the rank of mineral-water output by reason of the large production from a few springs supplying consumers in Minneapolis and St. Paul. The figures for

1907 show an increase of almost 12 per cent in the quantity sold. The actual figures reported are 9,654,030 gallons, valued at $524,800, which, compared with the 1906 output of 8,621,979 gallons, valued at $175,677, shows an increase of 1,032,051 gallons, or 11.97 per cent, and of $349,123, or 198.73 per cent.

The record for the last five years has been as follows:

*Production and value of mineral waters in Minnesota, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 4 | 2,228,000 | $46,470 | 1906 | 7 | 8,621,979 | $175,677 |
| 1904 | 4 | 902,500 | 21,545 | 1907 | 8 | 9,654,030 | 524,800 |
| 1905 | 6 | 7,681,650 | 132,970 | | | | |

The average retail price per gallon at the spring for 1907 was $0.05, an advance of 3 cents over the 1906 price. Less than 2 per cent of the water was sold for medicinal purposes, the bulk of it being for table use. One new spring reported sales for the first time in 1907—the Red Star. There are no resorts at the springs, but the water at 1 is said to be used for bathing.

The 8 reporting springs are as follows:

Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Indian Medical Spring, Elk River, Sherburne County.
Mankato Mineral Springs, near Eagle Lake, Blue Earth County.
Owatonna Vichy Spring, Owatonna, Steele County.
Red Star Spring, Cold Spring, Stearns County.
Rock Spring, Shakopee, Scott County.
Trio Siloam Spring, Austin, Mower County.

## MISSISSIPPI.

The mineral-water trade of Mississippi seems to have enjoyed prosperity during 1907, the sales increasing from 254,279 gallons in 1906 to 425,500 in 1907, an increase of 171,221 gallons, or 67 per cent. The value also increased from $52,820 in 1906 to $93,350 in 1907, a gain of $40,530, or almost 77 per cent. The average retail price per gallon at the spring was $0.22. Improvements at resorts and better facilities for reaching the springs are among the causes given by producers to account for the growing demand for spring water. Less than one-tenth of the water is used for table purposes, the bulk being medicinal. No new springs reported sales in 1907, the total number being the same as in 1906. Resorts are situated at 7 of the springs with accommodations for 775 people, and the water at 5 is used for bathing purposes. The list of reporting springs follows:

Arundel Lithia Spring, near Meridian, Lauderdale County.
Browns Wells, near Hazlehurst, Copiah County.
Castalian Spring, near Durant, Holmes County.
Lauderdale Springs, Lauderdale, Lauderdale County.
Mammoth Spring, Mammoth Springs, Perry County.
Robinson Springs, near Pocahontas, Madison County.
Stafford Mineral Springs, Vossburg, Jasper County.
Vossburg Lithia Spring, Vossburg, Jasper County.

## MISSOURI.

The returns from Missouri show a small increase in the mineral-water trade during 1907, in spite of a considerable deduction for water used in making ginger ale, etc. The output is given as 667,232 gallons, valued at $103,314, an increase over 1906 of 48,832 gallons and $6,769. The average retail price per gallon at the spring was $0.15. About two-fifths of the total is used for medicinal purposes, the remainder being table water. Reports were received from 4 new springs, the Bochert, Hornet Mineral, Salt Sulphur, and Tiffany, and the total number making returns of sales was 18, an increase of 1 over 1906. At several of the Missouri springs the water is given away to visitors or furnished free to guests at the hotels, and these springs have been eliminated this year from the list of those reporting sales. Resorts are situated at 9 of the springs, with accommodations for 7,000 people, and the water at 5 is used for bathing. Those springs from which reports of sales are at hand are as follows:

American Spring, St. Louis, St. Louis City County.
Aqua Vitae Mineral Spring, Canton, Lewis County.
B. B. Mineral Spring, near Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick Spring, Blue Lick, Saline County.
Bochert Springs, near De Soto, Jefferson County.
Central Park Lithia Spring, Excelsior Springs, Clay County.
Crystal Lithium Spring, Excelsior Springs, Clay County.
Cusenbary Spring, near Kansas City, Jackson County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Hornet Mineral Springs, Bowling Green, Pike County.
Jackson Lithia Spring, Mount Washington, Jackson County.
Kalinat and Ionian Lithia Springs, near Bowling Green, Pike County.
McAllister Springs, McAllister Springs, Saline County.
Salt Sulphur Spring, Excelsior Springs, Clay County.
Soda-Carbonic Spring, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.
Tiffany Spring, near Parkville, Platt County.

## MONTANA.

The mineral water trade of Montana prospered during 1907. One new spring was added to the list, the Silesia Mineral. Less than one-tenth of the water of the 2 springs is used for medicinal purposes. There is no resort at either spring, but the water of 1 is used for bathing. The springs are:

Lissner's Mineral Spring, Helena, Lewis and Clark County.
Silesia Mineral Spring, Silesia, Carbon County.

## NEBRASKA.

There was no change in the list of mineral springs in Nebraska, the same spring reporting as heretofore. The water is sold for both medicinal and table purposes, and the spring is the site of a resort where the water is used for bathing. The name of this spring follows:

Shogo Lithia Spring, Milford, Seward County.

## NEW HAMPSHIRE.

There was a great decline in the mineral-water trade of New Hampshire during 1907, the output falling off 56 per cent. The figures reported for 1907 are 343,500 gallons, valued at $164,943, against 781,500 gallons in 1906, valued at $230,650, a loss of 438,500 gallons in quantity and of $65,707 in value. The producers report no special reason for this decrease, though a large quantity was eliminated this year as going into the manufacture of various drinks. One new spring reported, the Wilton Mineral. Altogether there were 6 springs reporting sales, an increase of 1 over last year. There are resorts at 2 of these, with accommodations for 60 guests. None of the water is used for bathing. The 6 springs reporting sales are as follows:

Amherst Mineral Spring, Amherst, Hillsboro County.
Granite State Spring, Plaistow, Rockingham County.
Lafayette Mineral Spring, Derry, Rockingham County.
Londonderry Lithia Spring, Londonderry, Rockingham County.
Pack Monadnock Lithia Spring, Temple, Hillsboro County.
Wilton Mineral Spring, near Wilton, Hillsboro County.

### NEW JERSEY.

New Jersey continued to show a large increase in mineral-water output, the increase in 1907 being somewhat over 67 per cent. According to reports from producers there were sold during the year 982,445 gallons of water, valued at $103,082, a gain of 397,230 gallons in quantity and of $37,896 in value. The average retail price per gallon at the spring was $0.11. The bulk of the New Jersey water is used for table purposes. Nearly every spring reporting showed an increase in its trade, more advertising and consequently greater demand being the principal cause stated. Two new producers reported, the Culm Rock and the Ironrock, the total springs reporting sales being increased by 2. A few of the springs state that they are the sites of resorts, but at none is the water used for bathing. Statements of sales were received from the following:

Alpha Mineral Spring, Springfield, Union County.
Beech Spring, near Woodbury, Gloucester County.
Culm Rock Spring, Pluckemin, Somerset County.
Hatawanna, Budd Lake, Morris County.
Indian Spring, near Rockaway, Morris County.
Ironrock Mineral Springs, Camden County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.
Red Rock Spring, Spring Valley Road, Bergen County.
Trinity Springs, Morsemere, Bergen County.
Watchung Spring, North Plainfield Township, Somerset County.

### NEW MEXICO.

There was a decline in New Mexico's mineral-water trade during 1907, the output decreasing 28,200 gallons, or 30 per cent. The value decreased in even greater proportion, from $17,700 in 1906 to $9,120 in 1907. The average retail price per gallon was $0.14, as against $0.19 in 1906. One spring reported for the first time, the Alvarado, this spring having bought the business of one of the older springs. About half of the water is used for medicinal purposes and half for table use. Resorts are situated at 2 of the springs, accommodating about 150 guests, and at 3 the water is used for bathing. Those springs reporting sales are as follows:

Alvarado Spring, near Albuquerque, Bernalillo County.
Faywood Hot Springs, Faywood, Grant County.
Macbeth Spring, near Las Vegas, San Miguel County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

## NEW YORK.

New York showed an increase in its output of mineral water during the year, the sales increasing from 6,481,074 gallons in 1906 to 7,176,815 gallons in 1907, a gain of 695,741 gallons, or 10.73 per cent. The value, however, decreased, the average price per gallon declining from $0.14 in 1906 to $0.09 in 1907. A number of the Saratoga springs or wells which report a falling off in business attribute it to the drain on underground supplies by pumps of producers of carbon dioxide, a matter that is still before the courts.

The following table shows the output and value of mineral waters from New York for the last five years:

*Production and value of mineral waters in New York, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 48 | 1,827,408 | $1,432,801 | 1906 | 42 | 6,481,074 | $893,476 |
| 1904 | 41 | 6,352,517 | 783,244 | 1907 | 41 | 7,176,815 | 686,574 |
| 1905 | 40 | 5,619,878 | 652,680 | | | | |

Less than one-third of the 1907 output reported is used for medicinal purposes, the sales being chiefly table water. Three new producers are listed, the Elk, Monarch, and Os-We-Go. Several springs which have heretofore reported sales have been eliminated from the list—1 was temporarily suspended, at 2 the water is used exclusively by the guests, and 1 is used for town supply. The total number reporting was 41, a decrease of 1 from 1906. In 9 cases the springs are situated at or near resorts with accommodations for thousands of people, and at 4 the water is used for bathing.

Those reporting sales are as follows:

Artesian Lithia Spring, Ballston Spa, Saratoga County.
Artesian Natural Mineral Spring, Franklin Springs, Oneida County.
Avon Sulphur Spring, Avon, Livingston County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Boonville Mineral Springs, near Boonville, Oneida County.
Breesport Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Chautauqua Lithia Spring, West Portland, Chautauqua County.
Chemung Spring, Chemung, Chemung County.
Crystal Springs, near Oswego, Oswego County.
Deep Rock Spring, Oswego, Oswego County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Oswego, Oswego County.
Gardine White Sulphur Spring, Sharon Springs, Schoharie County.
Geneva Mineral Spring, Geneva, Ontario County.
Great Bear Spring, near Fulton, Oswego County.
Hide's Franklin Mineral Spring, Ballston Spa, Saratoga County.
Hornby Sulphur Spring, Hornby, Steuben County.
Magnetic Flint Rock Spring, Elmira, Chemung County.
Massena Mineral Spring, Massena Springs, St. Lawrence County.
Monarch Spring, Matteawan, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Os-We-Go Spring, Oswego, Oswego County.
Pleasant Valley Mineral Spring, Rheims, Steuben County.
Red Jacket Mineral Spring, Seneca Falls, Seneca County.

- Saratoga Springs, Saratoga County:
    - Arondack Spring.
    - Chief Spring.
    - Congress Spring.
    - Geyser Spring.
    - Hathorn Spring.
    - High Rock Spring.
    - Patterson Spring.
    - Royal Spring.
    - Saratoga Carlsbad Spring.
    - Saratoga Seltzer and Emperor Spring.
    - Star Spring.
- Setauket Spring, Setauket, Suffolk County.
- Split Rock Lithia Spring, Franklin Springs, Oneida County.
- Sun-Ray Spring, Ellenville, Ulster County.
- Sunset Spring, Haines Falls, Greene County.
- Vita Spring, Durkeetown, Washington County.
- Washington Lithia Spring, Ballston Spa, Saratoga County.

## NORTH CAROLINA.

There was a slight increase in the mineral-water output of North Carolina for 1907, the sales increasing from 156,352 gallons, valued at $31,413, in 1906 to 193,479 gallons, valued at $40,302, in 1907, a gain of 37,127 gallons in quantity and of $8,889 in value. The average retail price per gallon was $0.21. A great deal of the North Carolina mineral water was reported as used in the manufacture of soft drinks, making the increase much smaller than it would have been with this water included. About seven-eighths of the total output given was used for medicinal purposes, which accounts for the relatively high price per gallon. One new spring reported, the Mount Vernon, the total number reporting being the same as in 1906. Resorts are situated at 10 of the springs, with total accommodations for 1,615 people, and the water at 5 is used for bathing. The springs from which returns of sales were available are:

- All Healing Spring, Alkaline Springs, Alexander County.
- Barium Rock Spring, Barium Springs, Iredell County.
- Buckhorn Lithia Spring, Bullock, Granville County.
- Connelly Springs, Connelly Springs, Burke County.
- Haywood White Sulphur Spring, near Waynesville, Haywood County.
- Jackson Spring, Jackson Springs, Moore County.
- Mida Spring, near Charlotte, Mecklenburg County.
- Moore's Springs, Moores Springs, Stokes County.
- Mount Vernon Springs, Mount Vernon Springs, Chatham County.
- Panacea Spring, near Littleton, Warren County.
- Seven Springs, Seven Springs, Wayne County.
- Thompson Bromine and Arsenic Spring, Crumpler, Ashe County.
- Vade Mecum Spring, Vade Mecum, Stokes County.

## OHIO.

The returns from Ohio for 1907 indicate a falling off in output of about 14 per cent, the figures reported being 1,536,621 gallons, valued at $121,531, against 1,790,767 gallons, valued at $164,007, in 1906, a decrease of 254,146 gallons in quantity and of $42,476 in value. Most producers said they did more business than in 1906, however, and the apparent decline is due largely to the quantity of water reported used for making carbonated drinks in 1907.

The record for the State for the last five years is as follows:

*Production and value of mineral waters in Ohio, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 18 | 1,389,959 | $91,107 | 1906 | 27 | 1 790,767 | $164,007 |
| 1904 | 13 | 3,223,958 | 306,566 | 1907 | 24 | 1,536,621 | 121,531 |
| 1905 | 23 | 943,114 | 117,733 | | | | |

The average retail price per gallon of the 1907 output was $0.08, indicating that the bulk of the Ohio water is used for table purposes. Three springs that reported in 1906 are not included in the 1907 list, because all the output was used for soft drinks. Two new springs, the Belmont and the Crystal, are listed. There are resorts at only 3 of the 24 springs reporting, with accommodations for 300 guests and the water at 3 is used for bathing.

Those springs from which returns of sales were received are:

Arcturus Lithia Springs, Portage Township, Summit County.
Avondale Spring, Avondale Heights, Belmont County.
Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Spring, near Martins Ferry, Belmont County.
Deerfield Spring, Deerfield, Portage County.
Fargo Mineral Springs, Asthabula, Ashtabula County.
Fisher's Magnesia Mineral Spring, North Columbus, Franklin County.
Jefferson Spring, Bloom Township, Fairfield County.
Navahoe Spring, near New Paris, Preble County.
Oak Ridge Mineral Springs, Greenspring, Sandusky County.
Odevene Spring, Delaware, Delaware County.
Painesville Mineral Spring, Painesville, Lake County.
Quakerdale Spring, Colerain, Belmont County.
Reynold's Artesian Well, Greenspring, Sandusky County.
Ripley Bromo Lithia Spring, Ripley, Brown County.
Sandrock Spring, Canton, Stark County.
Sulphur Lick Spring, near Chillicothe, Ross County.
Tallewanda Mineral Spring, College Corner, Preble County.
Wheeler Mineral Spring, Youngstown, Mahoning County.
Wood's Lithia Spring, near Bridgeport, Belmont County.

## OKLAHOMA.

This year the Oklahoma list includes springs formerly credited to Indian Territory. There appears to have been a slight decline in the trade, the output falling off from 72,419 gallons, valued at $7,744, in 1906 to 69,725 gallons, valued at $7,345, in 1907, a decrease of 2,694 gallons in quantity and of $399 in value. One new spring was added to the list, the Oklahoma Hygienic. Two of the springs are said to be located at resorts, with accommodations for 250 people and with facilities for bathing. The 4 springs reporting sales are as follows:

Beach Spring, Sulphur, Murray County.
Germicide Well, Wagoner, Wagoner County.
Lewis Crystalline Lithia Well, Oklahoma City, Oklahoma County.
Oklahoma Hygienic Mineral Well, Perry, Noble County.

## OREGON.

There was an apparent falling off in the mineral-water output of Oregon during 1907. The figures reported are 24,225 gallons sold, valued at $5,556, against 30,850 gallons sold in 1906, valued at $12,523, a decrease of 6,625 gallons and of $6,967. The average retail price per gallon was $0.23, against $0.41 in 1906. A cool August and the business depression affected trade at those springs that are resorts, but the increased deduction for soft-drink manufacture accounts for the decline shown. The total number reporting sales is 2 less than in 1906. A little more than half of the water is used for table purposes. Resorts are situated at 4 of the springs, and the water at 3 is used for bathing purposes.

Those springs reporting sales are:

**Cascade Mineral Spring, Cascadia, Linn County.**
**Colestin Spring, Colestin, Jackson County.**
**McBean's Soda Springs, near Seneca, Grant County.**
**Sodaville Mineral Spring, Sodaville, Linn County.**
**Wagner's Spring, Soda Springs, Jackson County.**

## PENNSYLVANIA.

Although the returns from Pennsylvania indicate a decrease in both quantity and value of the output, this falling off is probably more apparent than real, as most producers state that business was better than in 1906. Several springs which have heretofore reported sales were idle during 1907 or their water was used exclusively by guests at hotels, and one large spring was transferred to Maryland. This accounts for part of the decrease, but the chief factor is the great quantity of water reported as used in the manufacture of soft drinks. The stated output for 1907 was 1,287,063 gallons sold, valued at $235,807, as against 1,506,286 gallons sold in 1906, valued at $280,054, a decrease of 219,223 gallons in quantity and of $44,247 in value. The average retail price per gallon at the spring was $0.18.

The following table shows the output and value of mineral water from Pennsylvania from 1903 to 1907, inclusive:

*Production and value of mineral waters in Pennsylvania, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 29 | 1,522,860 | $357,579 | 1906 | 27 | 1,506,286 | $280,054 |
| 1904 | 21 | 743,050 | 90,465 | 1907 | 28 | 1,287,063 | 235,807 |
| 1905 | 27 | 1,322,594 | 194,113 | | | | |

Less than one-third of the 1907 output given was used for medicinal purposes, the bulk being sold for drinking and table purposes. Three new producers reported, the Keckshurg, the Keystone, and the Wilson, the total number reporting sales being 1 more than last year. Twelve of the springs are situated at or near resorts with total accommodations for 1,995 people, and the water at 8 is used for bathing.

The 28 springs reporting are as follows:

Bedford Chalybeate Spring, near Bedford, Bedford County.
Bedford Mineral Spring, near Bedford, Bedford County.
Black Barren Mineral Spring, Pleasant Grove, Lancaster County.
Bruce Subrock Spring, Pittsburg, Allegheny County.
Cloverdale Lithia Spring, near Newville, Cumberland County.
Colvin's White Sulphur Spring, Sulphur Springs, Bedford County.
Crystal Spring, Ephrata, Lancaster County.
De Profundus and Chalybeate Spring, Saegertown, Crawford County.
De Vita Mineral Spring, Cambridge Springs, Crawford County.
East Mountain Lithia Spring, near Factoryville, Wyoming County.
Glacier Spring, Ephrata, Lancaster County.
Glen Summit Spring, Glen Summit Springs, Luzerne County.
Gray Spring, Cambridge Springs, Crawford County.
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Kecksburg Artesian Mineral Spring, Kecksburg, Westmoreland County.
Keystone Spring, Factoryville, Wyoming County.
Lang Spring, Venango, Crawford County.
Magnesia Springs, Cambridge Springs, Crawford County.
Pavilion Spring, South Mountain, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Pocono Mineral Spring, Bucks Township, Luzerne County.
Pulaski Springs, Pulaski, Lawrence County.
Ross-Common Spring, Ross-Common, Monroe County.
Shohola Spring, Walker Lake, Pike County.
Tuckahoe Mineral Spring, near Northumberland, Northumberland County
Whann Lithia Spring, Franklin, Venango County.
White House Spring, Neversink Mountain, Berks County.
Wilson Spring, Mount Pocono, Monroe County.

## RHODE ISLAND.

There was an increase in the mineral water trade of Rhode Island during 1907, the sales increasing from 220,770 gallons, valued at $16,161, in 1906, to 245,307 gallons, valued at $17,108, in 1907, a gain of 24,537 gallons and of $947. The average retail price per gallon was the same as in 1906, $0.07. The entire output from Rhode Island is used for table purposes. There were no new springs, the total number reporting being the same as in 1906. They are:

Berry Spring, Pawtucket, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holly Mineral Spring, East Woonsocket, Providence County.
Ochee Mineral Spring, Johnston, Providence County.

## SOUTH CAROLINA.

South Carolina showed a decline in mineral water production during 1907, due almost entirely to the falling off in output of one spring. Several other springs stated that the bulk of their production was used for the manufacture of soft drinks, the total reported output of one being thus marketed, and this lessened the totals for the State. One spring failed to make returns and another which reported last year could not be located. The figures reported are 786,754 gallons, sold at $195,182, a decrease of 671,740 gallons and of $153,562 from the 1906 output of 1,458,494 gallons, valued at $348,744. Two new springs made returns of sales, the Cokesbury and the Mathias, the total number reporting sales being 1 more than in 1906. By far the larger part of the output is used for medicinal purposes, the average retail price per gallon being $0.25. Resorts are situated at 6 of the springs, with total accommodations for 1,360 people, but the water at only 1 is used for bathing. The springs which reported sales are as follows:

Antley Springs, St. Matthews, Orangeburg County.
Buffalo Lick Springs, Carlisle, Union County.
Cherokee Spring, Spartanburg, Spartanburg County.
Chick Springs, Greenville, Greenville County.
Cokesbury Mineral Spring, near Cokesbury, Greenwood County.
Glenn Springs, Glenn Springs, Spartanburg County.
Glowing Springs, Dresden, Abbeville County.
Harris Lithia Spring, Harris Springs, Laurens County.
Mathias Spring, near Columbia, Lexington County.
Rives Mineral Spring, near Lancaster, Lancaster County.
Rock Cliff Lithia Spring, Spartanburg, Spartanburg County.
White Diamond Lithia Spring, near Kings Creek, Cherokee County.
White Stone Lithia Spring, White Stone Springs, Spartanburg County.

## SOUTH DAKOTA.

Although there are a number of springs in South Dakota that are health resorts, there is but 1 which reports selling water. The bulk of the output from this spring is used for making carbonated drinks, the remainder being sold for table use. The spring is the site of a resort and the water is used for bathing. The name of this spring is:

Minnehaha Springs, Sioux Falls, Minnehaha County.

## TENNESSEE.

There was a decided increase in the output of mineral water from Tennessee during 1907, the sales amounting to nearly twice those of 1906. The poor quality of the water supply at one city is responsible for part of this gain. The sales reported were: 758,312 gallons, valued at $85,249, a gain of 346,614 gallons and of $26,778 over the 1906 production of 411,698 gallons, valued at $58,471. The average retail price was $0.11 against $0.14 reported for 1906. About two-thirds of the output was used for medicinal purposes. Four new springs—the Deep Cave, the Gammons, the Emerald, and the Riovista—reported in 1907, making the total number to report sales 16. There are resorts situated at or near 12 of these, with accommodations for 2,175 people, and the water at 5 is used for bathing purposes. The springs listed as selling water are:

Bon Aqua Springs, Bon Aqua, Hickman County.
Deep Cave Mineral Well, Eastland, Davidson County.
East Brook Springs, Cumberland Mountains, Franklin County.
Gammons Spring, near Tate Spring, Grainger County.
Hinson Springs, near Lexington, Henderson County.
Horn Springs, Horn Springs, Wilson County.
Idaho Springs, near Clarksville, Montgomery County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Red Boiling Springs, Redboiling Springs, Macon County.
Rhea Springs, Rhea Springs, Rhea County.
Richardsons Lockeland Spring, near Nashville, Davidson County.
Riovista Spring, Davidson County.
Tate Spring, Tate Springs, Grainger County.
Whittle Springs, Whittle Springs, Knox County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

## TEXAS.

Texas showed a growing prosperity in its mineral-water trade, the 1907 output increasing nearly 10 per cent over that of 1906, and the value gaining in even greater ratio. This growth is largely due to efforts to get business. The famous wells at Mineral Wells in Palo Pinto County supply more than half the output. According to returns received, there were sold during the year 1,146,279 gallons, valued at $152,233, a gain of 100,964 gallons and of $30,148 over the 1906 production of 1,045,315 gallons, valued at $122,085. About five-sixths of the total output was used for medicinal purposes. Two new springs reported, the Carlsbad Dyspepsia and the Vaca-Tesia. Several springs were reported in course of development and will no doubt be able to make returns for 1908. The total number reporting was 5 less than in 1906.

The record of the State for the last five years has been as follows:

*Production and value of mineral waters in Texas, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 21 | 939,390 | $53,613 | 1906 | 28 | 1,045,315 | $122,085 |
| 1904 | 14 | 1,142,500 | 64,923 | 1907 | 23 | 1,146,279 | 152,233 |
| 1905 | 28 | 1,526,970 | 144,421 | | | | |

There are resorts located at 13 of the springs reporting in 1907, with accommodations for several thousand people, Mineral Wells alone reporting a capacity for 10,000 guests. The water at 10 is used for bathing.

The following gave statements of sales:

Allison, Crystal, and Patterson Springs, Oran, Palo Pinto County.
Burdette Well, near Lockhart, Caldwell County.
Carlsbad Dyspepsia Spring, Blossom, Lamar County.
Dalby Spring, Dalby Springs, Bowie County.
Dulling's Mineral Wells, near San Antonio, Bexar County.
Farrier Spring, Dalby Springs, Bowie County.
Georgetown Mineral Wells, Georgetown, Williamson County.
Loretto Mineral Wells, near Elkhart, Anderson County.
Love Mineral Well, Weatherford, Parker County.
Mineral Wells, Palo Pinto County:
    Barber Wells.
    Congress Well.
    Crazy Well.
    Gibson Well.
    Indian Well.
    Sangcura Well.
    Specific Well.
    Star Well.
Rains Tioga Mineral Well, Tioga, Grayson County.
Red Mineral Springs, Mount Pleasant, Titus County.
Rosborough Spring, near Marshall, Harrison County.
Simmons Well, Tioga, Grayson County.
Texarkana Springs, Texarkana, Bowie County.
Vaca-Tesia Spring, Port Lavaca, Calhoun County.

## UTAH.

There is but one spring in Utah which reported water sold during 1907, all of which was used for medicinal purposes. This is:

Deseret Springs, Deseret, Millard County.

## VERMONT.

There was an increase of nearly 15 per cent in the sales of mineral waters in Vermont during 1907. The value, however, decreased almost 10 per cent, the average price being $0.23 against $0.29 for 1906. According to the figures received, 88,550 gallons were sold during 1907, valued at $19,948, as compared with 77,500 gallons in 1906, valued at $22,150, a gain of 11,050 gallons in quantity and a loss of $2,202 in value. Less than one-half of the output was sold for medicinal purposes, the bulk being for table use. One new spring reported sales, the Vermont, the total number listed being 1 more than in 1906. Resorts are situated at 4 of the springs, with accommodations for 1,275 people, and the water at 4 is used for bathing purposes. The list of springs stated to have sold water in 1907 follows:

Alburg Sulphur and Lithia Springs, Alburg Springs, Grand Isle County.
Brunswick Sulphur Springs, Brunswick, Essex County.
Clarendon Spring, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Spring, Sheldon, Franklin County.
Vermont Spring, West Haven, Rutland County.
Vermont Spring, Brookline, Windham County.

## VIRGINIA.

The returns from Virginia show a notable growth in the quantity of mineral water sold, the increase for 1907 being about 22 per cent, though the value increased in much smaller ratio. Much of the gain for the year is to be credited to sales at the Jamestown Exposition. According to figures reported there were marketed 2,442,075 gallons, valued at $431,770, in 1907, the average retail price per gallon being $0.18. These figures, compared with the totals for 1906, 1,997,207 gallons, valued at $418,908, show an increase in quantity of 444,868 gallons and in value of $12,862.

The following table gives the record of mineral water output from Virginia from 1903 to 1907, inclusive:

*Production and value of mineral waters in Virginia, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|
| 1903 | 41 | 2,561,502 | $477,410 |
| 1904 | 35 | 2,117,420 | 281,998 |
| 1905 | 37 | 2,340,287 | 549,102 |
| 1906 | 43 | 1,997,207 | $418,908 |
| 1907 | 44 | 2,442,075 | 431,770 |

About two-thirds of the 1907 output, valued at $284,224, was used for medicinal purposes, the remainder being classed as table water. Two springs not listed in 1906 reported sales—the Diamond and the Virginia Magnesian Alkaline springs—making the total number of reported producers 44. There are resorts at or near 14 of these springs, with total accommodations for 1,840 people, and the water at 9 is said to be used for bathing.

The list of producing springs follows:

Alleghany Spring, Alleghany Spring, Montgomery County.
Artesian Well, Mulberry Island, Warwick County.
Bath Alum Springs, McClung, Bath County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, near Bon Air, Chesterfield County.
Bellfont Lithia Spring, near Manchester, Chesterfield County.
Berry Hill Mineral Spring, near Elkwood, Culpeper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Buckhead Lithia Spring, Buckhead Springs, Chesterfield County.
Buffalo Lithia Spring, Buffalo Lithia Springs, Mecklenburg County.
Burnetts Spring, Hudson Mill, Culpeper County.
Campfield Lithia Spring, Chesterfield County.
Como Lithia Spring, East Richmond, Henrico County.
Crockett Arsenic Lithia Spring, Crockett Springs, Montgomery County.
Days Point Artesian Lithia Spring, Isle of Wight County.
Diamond Spring, near Waterway, Princess Anne County.
Erup Mineral Spring, near Glencarlyn, Alexandria County.
Farmville Lithia Springs, Farmville, Cumberland County.
Fonticello Lithia Spring, near Richmond, Chesterfield County.
Golindo Spring, near Cave Station, Augusta County.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Holly Springs, near Swansboro, Chesterfield County.
Houston Chlorated Lithia Spring, Houston, Halifax County.
Hume Spring, Barcroft, Alexandria County.
Jeffress Lithia Spring, Jeffress, Mecklenburg County.
Jordan White Sulphur Spring, Jordan Springs, Frederick County.
Kayser Lithia Springs, Staunton, Augusta County.
Lone Jack Spring, near Lone Jack Station, Campbell County.
Magee's Chlorinated Lithia Spring, Clarksville, Mecklenburg County.
Massanetta Spring, Penn Laird, Rockingham County.
Mecklenburg Mineral Spring, Chase City, Mecklenburg County.
Nye Lithia Springs, Wytheville, Wythe County.
O'Connell Lithia Spring, near Staunton, Augusta County.
Otterburn Lithia Spring, near Amelia, Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Powhatan Spring, near Ballston, Alexandria County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Magnesian Lithia Springs, near Staunton, Augusta County.
Stribling Springs, near Mount Solon, Augusta County.
Virginia Etna Lithia Springs, Vinton, Roanoke County.
Virginia Lithia Springs, near Manchester, Chesterfield County.
Virginia Magnesian Alkaline Spring, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
Wyrick Mineral Spring, Crockett, Wythe County.

## WASHINGTON.

There was a large increase (78 per cent) in the mineral-water output of Washington during 1907, chiefly due to the activity of owners in securing customers. According to the reports received there were sold during the year 68,400 gallons having a value of $10,820, against 38,500 gallons valued at $10,800 in 1906, a gain in quantity of 29,900 gallons and in value of $20. The average retail price per gallon was $0.16 against $0.28 in 1906. About three-fifths of the output was used for table purposes. No new springs reported, but 2 were omitted, as the water is used exclusively by guests of the hotels at the springs. Two of the 4 springs selling water are used as resorts, with accommodations for 350 guests, and the water at 1 is used for bathing purposes. Those springs from which reports of sales were available are:

Birch Hills Mineral Springs, near Chattaroy, Spokane County.
Moffett Hot Springs, near Moffett Springs, Skamania County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Soda Springs, Ahtanum Mountains, Yakima County.

## WEST VIRGINIA.

Owing to a good demand the mineral water trade of West Virginia prospered during 1907, the sales increasing more than 10 per cent, and the value gaining in much larger ratio. According to reports received from producers, there were 135,809 gallons sold during 1907, valued at $79,659, against 122,880 gallons sold in 1906, valued at $57,460, an increase of 12,929 gallons and of $22,199. The average price per gallon rose from $0.33 in 1906 to $0.59 in 1907. Most of the water was used for medicinal purposes. One new spring reported sales, the Green Sulphur, the total number being the same as in 1906. There are resorts situated at or near 8 springs, with accommodations for several thousand people, and the water at 7 is used for bathing.

The names of those reporting sales follow:

Basilithic Salt Spring, Webster Springs, Webster County.
Borland Mineral Wells, Borland, Wood County.
Green Sulphur Spring, Sandstone, Summers County.
Greenbrier Alum Spring, Maxwelton, Greenbrier County.
Greenbrier Springs, near Talcott, Summers County.
Man-A-Cea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Stratford Magnesia Spring, Woodlawn, Ohio County.
Webster Springs, Elk Valley, Webster County.
White Sulphur Spring, White Sulphur Springs, Greenbrier County.

## WISCONSIN.

Owing to the large quantity of water now used in making ginger ale, etc., the returns as published in the tables of production showed a decrease in the mineral water trade of Wisconsin during 1907. It has been estimated that more than 2,500,000 gallons were used for manufacturing soft drinks, and the reports received show shipments of over 1,300,000 gallons for that purpose. The Waukesha springs reported a good year. It is stated that there were sold 6,839,219 gallons of water, valued at $1,526,703, during 1907, against 7,702,718 gallons, valued at $2,397,694, in 1906, a decrease of 863,499 gallons in quantity and of $870,991 in value. The average retail price for the year was $0.22, indicating a fall in price.

The following table shows the number of springs reporting sales, the quantity sold, and the value thereof for the last five years:

*Production and value of mineral waters in Wisconsin, 1903–1907.*

| Year. | Springs reporting sales. | Quantity sold (gallons). | Value. | Year. | Springs reporting sales. | Quantity sold (gallons). | Value. |
|---|---|---|---|---|---|---|---|
| 1903 | 26 | 1,293,777 | $1,058,954 | 1906 | 27 | 7,702,718 | $2,397,694 |
| 1904 | 25 | 6,586,834 | 1,546,535 | 1907 | 29 | 6,839,219 | 1,526,703 |
| 1905 | 27 | 6,656,834 | 1,454,715 | | | | |

About two-thirds of the output given for 1907 was used for table purposes, the remainder being classed as medicinal. Two new springs are listed, the Elim Mineral and the Waukesha Roxo, making the total number of springs reporting 29, or 2 more than in 1906. There were resorts at 6 of these springs, accommodating in all 2,325 people, and the water at 2 is used for bathing.

The following is the list of producers reporting sales:

Allouez Spring, Green Bay, Brown County.
Alta Spring, Dunfield, Lincoln County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Darlington Mineral Spring, Darlington, Lafayette County.
Elim Mineral Spring, Milwaukee, Milwaukee County.
Endter's Crystal Mineral Spring, Oshkosh, Winnebago County.
Fort Crawford Spring, Prairie du Chien, Crawford County.
Hiawatha Springs, Hiawatha Springs, Rock County.
Nee-Ska-Ra Spring, Wauwatosa, Milwaukee County.
Maribel Mineral Spring, Maribel, Manitowoc County.
St. John Mineral Spring, Green Bay, Brown County.
Salvator Mineral Spring, Green Bay, Brown County.
Sanitas Fountain Spring, near Oshkosh, Winnebago County.
Sheboygan Mineral Spring, Sheboygan, Sheboygan County.
Solon Springs, Solon Springs, Douglas County.
Waukesha Springs, Waukesha County:
    Almanaris Spring.
    Anderson's Spring.
    Arcadian Spring.
    Bethesda Spring.
    Clysmic Spring.
    Crystal Rock Spring.
    Glenn Rock Spring.
    Imperial Spring.
    Roxo Spring.
    Silurian Spring.
    White Rock Spring.
Wautoma Rainbow Mineral Spring, Wautoma, Waushara County.

### WYOMING.

The only spring to report sales from Wyoming was a resort where the waters are drunk and used for bathing by guests at a hotel. The water sold is entirely for table use.

Saratoga Hot Springs, Saratoga, Carbon County.

## IMPORTS AND EXPORTS.

### IMPORTS.

Imports of mineral water entered for consumption in this country amounted during 1907 to 3,497,239 gallons, valued at $1,165,555, an increase of nearly 11 per cent in quantity and of 15 per cent in value compared with the 1906 returns. Imports for the past six years, as reported by the Bureau of Statistics, are given below. They include natural spring waters, prepared mixtures of water from different springs, and artificial waters.

*Mineral waters imported and entered for consumption in the United States, 1902–1907, in gallons.*

| Year. | Mineral waters. | | Year. | Mineral waters. | |
|---|---|---|---|---|---|
| | Quantity. | Value. | | Quantity. | Value. |
| 1903. | | | 1905 | 3,150,080 | $926,357 |
| 1902 | 2,461,830 | $712,827 | 1906 | 3,157,609 | 1,012,333 |
| 1903 | 2,851,964 | 846,294 | 1907 | 3,497,239 | 1,165,555 |
| 1904 | 2,901,828 | 868,262 | | | |

## EXPORTS.

Though the proprietors of several springs state that they have agents in Canada and Mexico and ship water to these and other foreign countries, no note of exports is taken by the Department of Commerce and Labor, and no exports have been reported by the Bureau of Statistics since 1883.

# MONAZITE AND ZIRCON.

By Douglas B. Sterrett.

## INTRODUCTION.

The commercial value of the mineral monazite is largely due to the presence of the element thorium. As a source of other rare earth metals, also, monazite is of considerable interest to chemists.

The principal use made of the thoria (oxide of thorium) extracted from monazite, is in the manufacture of incandescent mantles for gas lighting. These mantles are made by immersing sections of cotton gauze or netting, woven in tubular form, in a saturated solution of the salts of certain rare earths. The composition of this mixture of salts used by different manufacturers is kept secret, but it is said to contain thorium largely in excess of the other constituents. The sections of the tubes are then dried after one end has been drawn into the form of a mantle by a platinum wire. When dry, the organic matter of the cotton is burned off and the mantle is saturated with some form of wax, which holds it in shape during shipment and is readily burned off when it is set up for use.

Of great scientific interest and of probable commercial value is the discovery by Auer von Welsbach[a] that certain alloys of iron with cerium, lanthanum, and other rare metals obtained from monazite possess the property of emitting brilliant sparks when scratched with a knife or file. When strongly pressed with a piece of steel, the alloy is said to emit an apparent flame of great brilliancy and with little heat and smoke. The sparks readily ignite gases, tinder, alcohol wicks, and explosives such as are used in blasting and gunnery. The alloy could be made to ignite gaslights by the friction of a piece of steel moved against it by an electro-magnet. The ignition of explosives might be accomplished with this alloy more safely than with fulminates. The flame may be serviceable in flash-light photography, dispensing with the disagreeable smoke of magnesium powders; also in military signaling. The character of the light is said to vary with the nature of the alloys, several of which are made at Treibach, Austria, and cost from $6 to $7 per pound. Most of the alloys are composed of more than one rare metal with iron—as "lanthan," which contains both lanthanum and cerium; "erdmetal," which contains several rare metals, and "cer," which consists of only cerium and iron. The intensity of the sparks and the ease with which they may be produced are greatest in alloys containing iron up to 30 per cent. Alloys with 30 per cent of iron emit showers of bright sparks at the lightest touch with steel. The iron may be in part, though not entirely, replaced in these alloys by nickel, cobalt, or manganese.

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[a] Silberstein-Gilbert, Leo, Sci. American, February 8, 1908; condensed from New York Staats-Zeitung.

## THORIUM MINERALS.

Besides monazite, there are a number of other rare minerals which contain thorium. Up to the present only two of these, thorite and thorianite, have been found in sufficient quantity to be used as a commercial source of that element.

*Monazite.*—Monazite is essentially an anhydrous phosphate of cerium, lanthanum, praseodidymium, and neodidymium, with a variable percentage of silica and thoria. The proportion of thoria in monazite ranges from less than 1 per cent to more than 20 per cent, but the average quantity in monazite obtained for commercial purposes varies between 3 and 9 per cent. Monazite varies in color from grayish to yellow, to reddish, to brownish, and in some cases it is greenish. The luster is resinous and is especially brilliant on the cleavage faces. Monazite is opaque to translucent and subtransparent. The specific gravity varies from 4.9 to 5.3 and is mostly over 5. The mineral is brittle, with hardness of 5 to 5.5, and small grains may readily be crushed between the teeth.

*Thorite.*—Thorite is a silicate of thorium ($ThSiO_4$). Theoretically it contains 81.5 per cent of thoria, though practically it generally carries less than 70 per cent. It occurs in tetragonal crystals with the prism and pyramid forms similar to simple zircon crystals. The color of pure thorite, or orangite, as it is called, is orange-yellow to brownish-yellow, and of ordinary thorite, black inclining to brownish. The streak is light orange colored to dark brown. Thorite is subtransparent to opaque, with a vitreous to resinous luster. The hardness is 4.5 to 5, and the specific gravity is 4.5 for ordinary thorite and 5.4 for orangite.

*Thorianite.*—Thorianite[a] is composed of the oxides of thorium and uranium. Analyses do not indicate a definite compound, but an isomorphous mixture of those oxides. The proportion of thoria found in different analyses varies from less than 70 to nearly 80 per cent. Thorianite occurs in cubic crystals, which are sometimes twinned. The color on crystal faces is jet black and on worn surfaces dull gray or brownish-black, and the luster is resinous to submetallic. The mineral is brittle and breaks with an uneven to conchoidal fracture. The hardness is 5.5 to 6, and the specific gravity is from 8 to 9.7. Thorianite dissolves in strong nitric or dilute sulphuric acid with the evolution of helium gas. It is highly radioactive, though less so than some pitchblendes.

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[a] Dunstan, W. R., Proc. Royal Soc. London, vol. 76, 1905, pp. 253–265. Coomaraswamy, A. K., Ceylon Administration Repts., 1904, pt. 4, pp. E6–E8.

# MONAZITE.

## OCCURRENCE OF MONAZITE AND THORIUM MINERALS IN THE UNITED STATES.

### SOUTHERN STATES.

Monazite is of widespread occurrence in the United States, though large deposits have been found in but few regions. Up to the present time the production for commercial purposes has come entirely from North Carolina and South Carolina. The area in which deposits of monazite of commercial value have been found in these States lies in the central part of western North Carolina and in the extreme northwestern part of South Carolina. This area covers about 3,500 square miles and includes part or all of Alexander, Iredell, Caldwell, Catawba, Burke, McDowell, Gaston, Lincoln, Cleveland, Rutherford, and Polk counties in North Carolina, and Cherokee, Laurens, Spartanburg, Greenville, Pickens, Anderson, and Oconee counties in South Carolina. The larger towns within or near the monazite region are Statesville, Hickory, and Shelby in North Carolina, and Gaffney, Spartanburg, and Greenville in South Carolina. The appearance of Alexander County, N. C., in the list of counties with valuable monazite deposits is the result of prospecting by mining companies during 1907. It is probable that this area will be gradually extended both to the northeast and to the southwest. According to Mr. George L. English, who has thoroughly prospected Alexander County for monazite, the concentrates obtained from the gravels probably average from 25 to 30 per cent monazite, though they are far richer locally. Several deposits of monazite occur in northeastern Georgia, though their value has not yet been proved. One of these, in Rabun County, made a good showing for both gold and monazite in a preliminary test. In Jackson County, N. C., adjoining, monazite was found in several pannings made by the writer in the Horse Cove region, 2 miles east of Highlands. Monazite occurs at a number of other places in the mountain region of North Carolina, and is seen at many places in small quantities in concentrates made from pannings in areas of pegmatized gneisses and schists. Several small deposits of fairly rich monazite-bearing gravels are reported by Mr. George L. English to occur in Clay County, N. C. The lack of large areas of bottom lands, however, limits the value of these deposits.

Though sometimes found in large crystals and masses of many pounds' weight in pegmatite rocks, such as are mined for mica, monazite for commercial purposes is obtained in the form of sand. This sand occurs in gravels in the beds of creeks and streams and in the adjoining bottom lands. The thickness of the gravels ranges from 1 foot, including overburden, to 6 feet or more. The distribution of the monazite in them is, as with all heavy minerals, richer near the bedrock and poorer above, grading into the overburden. In some deposits the whole bed, with the finer alluvium at the surface, is rich enough to be washed directly or sluiced down and washed. The extent and value of these deposits vary with the topography of the country and the nature of the gravels. The best deposits are more commonly associated with light-colored gravels and sands, containing considerable quartz débris and fragments of other light-colored rocks, such as pegmatite, granite, mica, and cyanite gneiss. On the other hand, the absence of much quartz and pegmatitic or granitic débris from the gravels is generally characteristic of low-grade deposits of monazite. The presence of black sands—magnetite, ilmenite, hornblende, etc.—in the gravels does not necessarily indicate a low-grade monazite deposit, unless quartz and pegmatitic minerals are lacking also.

The best deposits of monazite have been found in or near areas where large granite masses outcrop or where pegmatization of the country rock has been extreme. On the other hand, where the gneisses and schists are nearly free from pegmatitic material and there are no granite masses in the neighborhood, the stream gravels are generally poor in monazite. The monazite occurring in place to any extent in the country rock has not been found in the ordinary pegmatite masses but in portions of the rock formations where there has been extensive pegmatization.

Monazite deposits in regions where hornblende rocks are abundant generally contain a large percentage of black sands, and it is then often difficult to concentrate the monazite to a marketable grade. As an offset to this, however, especially in regions where granite is associated with the hornblendic rocks, gold is often found in the concentrates in quantity more than sufficient to pay the cost of separation, and in the same localities the concentrates generally carry also a quantity of zircon. This zircon is in the form of small, clear crystals with a brilliant luster, which range in size up to 1 millimeter square and about 2 millimeters long. A fairly clean separation can be made by cleaning with an electromagnetic machine and careful washing. The quantity and the size of the zircon crystals found in the monazite concentrates are generally larger in deposits associated with granitic and hornblendic rocks than with other types. The same is commonly true with the quantity of gold in the concentrates. The soils adjoining rich bottom lands are in many places found to carry considerable monazite for a depth of 3 or 4 inches, while in places where the drift soil has collected on the gentle slopes below a steeper hillside it may contain a quantity of monazite to a depth of several feet. The partial concentration of monazite in the top layer of soil is caused by the washing away of the clay and other light decomposition products of the rock. The supply of monazite in the stream gravels in favorable areas is often replenished by the wash from the hillside soils during heavy rains. This occurs especially where the hills have any considerable slope and the land is cultivated. Under such conditions it is frequently profitable to work the steam gravels two or more times a year. It is possible, in favorable places where water can be readily obtained, to sluice portions of the soils rich in monazite down into the bed of the streams, where the monazite can easily be obtained by ordinary methods of concentration. In some places the saprolite or rotted rock underlying the richer deposits of monazite is found to carry appreciable quantities of that mineral, and portions of it are sluiced down and concentrated along with the gravels.

The percentage of monazite in both the original rock matrix and in the gravel deposits is small, and probably does not often run over 1 per cent. Figures are not available for the percentage of monazite in gravel deposits. From the saprolite underlying the F. K. McClurd mine, three-fourths of a mile northeast of Carpenter Knob, N. C., Mr. George L. English obtained about one-third of a pound of monazite per ton, or about 0.016 per cent. At the British Monazite mine, 3 miles northeast of Shelby, N. C., the quantity of monazite in the hard-rock formations was found by Mr. Hugh Stewart, engineer in charge, to run from between 0.03 per cent and less up to 1.10 per cent and more.

Monazite has generally been won from the placer deposits by washing in ordinary sluice boxes. Within the last three years, however, concentrating tables have been employed at several mines in the monazite region. One of these tables has been used for over two years on the Downs mine, 1 mile northwest of Carpenter Knob. This table is of local construction, being patterned on the general style of the Wilfley table, and is operated by a gasoline motor. The gravels are carted to the machine in wheelbarrows, and placed in a shaking hopper through which water is continually passing. The sand is washed through the hopper and over the table while the oversize is shoveled out. Two grades only are taken from this machine, concentrates and tailings. The concentrates are run over the table a second time and brought to a better shipping grade. The machine produces from 100 to 140 pounds of concentrates averaging 40 to 45 per cent of monazite in ten hours, and during the year 1907 produced between 20 and 25 tons of such concentrates.

The degree of concentration it is possible to attain by wet methods depends largely upon the composition of the gravels to be treated and the care used in treating them. Where black sands, such as magnetite, ilmenite, etc., and other minerals with a high specific gravity are abundant, it is difficult to bring the concentrates up to a good grade. Thus the concentrates obtained from the Golden Valley and Brindletown regions and other points along the northwest side of the monazite belt where hornblendic rocks are common seldom run over 35 per cent monazite and often run as low as 15 or 20 per cent. In other parts of the monazite region, composed chiefly of micaceous rocks, much higher grade concentrates can be obtained. Thus in the mines around Carpenter Knob the concentrates from sluice-box washing average from 40 to 50 per cent monazite, while in some places they will run over 60 per cent. There are mines in the monazite region (as the Smart mine, near Ellenboro, N. C.) where concentrates running from 75 to 80 per cent monazite can be obtained by sluice-box washing. The grade of sand obtained by washing on a good concentrating table is equal to or better than that obtained by careful sluice-box washing. Hydraulic mining has been used at several mines, though chiefly where the gravels are auriferous, as in the South Mountain region of Burke and Rutherford counties. In the Brindletown section of Burke County two such deposits have recently been worked by hydraulic methods. In one of these, on Brindle Creek, water was obtained under pressure from a fall of about 100 feet. The gravels were washed out from an area 30 to 50 feet wide and into a shallow depression at the head of the waste ditch. After two or three weeks of such washing the sluiced material was washed successively in two sluice boxes, and the monazite was brought to a shipping grade. The gold was caught on quicksilvered copper plates or by mercury in riffles after washing in the first box. In the other hydraulic operation pressure was obtained by a steam pump. The gravels were washed through a wooden sluice with riffles in the upper part for saving gold, and the sands were caught in settling dams below. These sand beds were later washed in sluice boxes.

The crude monazite concentrates are refined at three places in the monazite region of the Carolinas before shipping. The refining is accomplished by electromagnetic machines, of which two types are in use. Two of these are improved forms of the Wetherill machine, and are located near Ellenboro, N. C., and Gaffney, S. C. In these machines the different minerals are lifted from a conveying belt as they pass through electromagnetic fields of different degrees of intensity. The first field removes magnetic iron; the second titanic iron, garnet, and minerals of similar magnetic intensity; while the third and fourth fields remove the coarse and fine monazite, respectively. The nonmagnetic minerals, as quartz, zircon, rutile, gold, etc., pass off as tailings. By far the largest part of the monazite is cleaned on a specially designed machine at Shelby, N. C. The separation is accomplished by the deflection of the minerals as they fall through magnetic fields. The sands are first passed through an ordinary type of Wetherill machine to remove the magnetic iron. The product from the Wetherill is then passed over three belts and allowed to fall through three magnetic fields of different intensities in the new machine. The first field removes the titanic iron and part of the garnet, the second the remaining garnet and part of the monazite, and the third the remaining monazite. The product from the second field is treated a second time, and the monazite is readily separated from the garnet. The whole operation at this cleaning mill is automatic from the time the crude sand is put into the feed hopper for the Wetherill machine until the monazite is obtained as a high-grade concentrate.

The concentrates produced at these three cleaning mills will readily average 90 per cent or more of monazite. Early in the year part of the monazite produced by one company in North Carolina was cleaned on Wilfley and Overstrom concentrating tables. A clean product, running 90 per cent or more monazite, was obtained by milling ore with monazite in a rock matrix. It was not found profitable to mine monazite in this way, however, and operations were suspended in March, 1907. The electrostatic monazite cleaner at Hildebrand, N. C., was not operated during 1907, and it is understood that the company using it has permanently ceased operations in the monazite region.

### WESTERN STATES.

Appreciable quantities of monazite are found in gravel and sand beds in parts of California, Colorado, Idaho, Indiana, Montana, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.[a] In samples of sands from some of these States the tests made by the United States Geological Survey Concentrating Plant at Portland, Oreg., indicated rich deposits. In Idaho samples of sands tested indicated a wide occurrence of monazite and zircon, often associated with gold in the gravels. Near Centerville, in the Bòise Basin, Idaho, mining for monazite was undertaken in 1906 and continued in a small way through part of 1907. None of the product has been marketed as yet, since the price offered for monazite during 1907 has been so low.

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[a] Day, Davis T., and Richards, R. H., Black sands of the Pacific Slope: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1175–1258.

Of special interest is the recent discovery of monazite and small quantities of thorianite, by Mr. Wirt Tassin, of the United States National Museum, in concentrates obtained from the vicinity of Norris, Mont. These concentrates contained considerable magnetite and other black sands, with xenotime, zircon, garnet, quartz, and ruby spinel (sparingly). Analyses are being made of the thorianite and certain associated minerals by Mr. Tassin, who expects to publish the results when completed, along with information on the occurrence. The thorium content of the concentrates so far examined is low, though the presence of gold and other economic minerals may make the proposition a commercial one.

## FOREIGN SOURCES.

*Brazil.*—The greater part of the world's supply of monazite comes from Brazil. In that country the deposits lie along the coast of the States of Bahia and Espirito Santo, in the sand banks and dunes on the beaches. Gravel deposits along certain of the rivers in the interior are also now being worked for monazite. The exports of monazite from Brazil during the years 1902 to 1906 are given by Mr. C. D. Test,[a] as follows:

*Exports of monazite from Brazil, 1902–1906, in metric tons.*

| | |
|---|---|
| 1902 | 1,205 |
| 1903 | 3,299 |
| 1904 | 4,860 |
| 1905 | 4,437 |
| 1906 | 4,351 |

The average price is given as 11.06 cents per pound in 1904 and 8.57 cents per pound in 1905.

*South Australia.*—The occurrence of monazite in South Australia on Kangaroo Island, as noted in this report for 1906, has been confirmed by the government geologist, H. Y. L. Brown.[b] The discovery was made on the Eleanor River, about 28 miles west of Kingscote, where the sand was found in old prospect shafts and in the alluvium. An analysis of monazite crystals separated by hand from this sand yielded 8.4 per cent of thoria.

*Ceylon.*—Prospecting and mining for thorium minerals in Ceylon[c] have been continued. Up to 1906 thorite and thorianite were the only minerals produced as a source of thorium. Monazite of good grade has been found at a number of localities, however, and may prove of value, especially since it is, in some places at least, associated with the other thorium minerals. One sample of monazite yielded on analysis about 10 per cent of thoria. Other thorium minerals found in small quantities in Ceylon are zirkelite, carrying about 20 per cent thoria; tscheffkinite, 5 per cent thoria; and fergusonite, with about 2 per cent of thoria.

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[a] The occurrence, production, and commercial value of monazite: Bull. Colo. School of Mines, vol. 4, No. 2, January, 1908.

[b] Mining World, July 6, 1907.

[c] Ceylon Administration Repts., 1906, pt. 4, pp. E3–E4.

Up to 1905 thorite and thorianite were obtained from gravel deposits in certain parts of the island. In August of that year, however, thorianite was discovered in its matrix by following the thorianite-bearing gravels back to the ledge from which that mineral had come. The matrix proved to be weathered pegmatite in which kaolin and hydrated mica were the prominent constituents. A test made on this deposit yielded about 6 pounds of thorianite per ton of wet decomposed rock. Further investigations have shown that thorite and thorianite occur in place in pegmatitic material closely associated with a mica-spinel rock.

The exports of thorianite and thorite from Ceylon are given by Mr. James Parsons,[a] principal mineral surveyor of Ceylon, as follows:

*Exports of thorianite and thorite from Ceylon, 1905-1907, in pounds.*

| Year. | Thorianite. | Value. | Thorite. | Value. |
|---|---|---|---|---|
| 1905 | 17,900 | $24,100 | 100 | $97 |
| 1906 | 5,200 | 8,176 | | |
| 1907 | 1,000 | 1,541 | | |

Of the thorianite exports 350 pounds were to the United States; the greater part went to the United Kingdom, with some to Germany and Belgium. The decrease is largely due to the deposits being nearly exhausted, though partly to the decline in prices.

*Other countries.*—As recorded in this report for 1906, monazite occurs in Nigeria in Africa, in the province of Perm in Russia, and at Pahang in the Malay States. Mr. Test, in the article cited, mentions the occurrence of deposits of monazite in the United States of Colombia; in Gippsland in Victoria, Australia; in Siberia; in Norway, and in Trengganu, an independent Malay State.

## ZIRCON.

Contrary to expectation, the production of zircon was very small during 1907, amounting to only 204 pounds, valued at $46. This came from the mines in Henderson County, N. C., as in previous years. There seems to have been no commercial separation of zircon from monazite concentrates made during 1907. The investigations by the United States Geological Survey concentrating plant, under the direction of Dr. Joseph Hyde Pratt, at Chapel Hill, N. C., in 1907, were given up through the lack of funds. One of the objects of this work was to devise a cheap and satisfactory method of separating all the minerals of value occurring in the concentrates from the monazite region. As has been pointed out elsewhere, certain of these concentrates contain considerable zircon.

A new deposit of zircon has lately been reported by Mr. Frank Rush, forest supervisor for the Wichita National Forest, about 7 miles northwest of Cash, Okla. Specimens sent to the Survey by Mr. Rush consisted of portions of pegmatite rock through which zircon crystals up to three-fourths inch cube were thickly scattered.

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[a] Personal letter to the Director of the United States Geological Survey, dated March 5, 1908.

The crystals consisted of the simple pyramid faces with the prism almost entirely lacking. Most of the crystals were of deep red-brown color, though some were yellowish, and nearly colorless. Whether the mineral occurs in sufficient quantity to be of commercial value is not known, though the hand specimens examined were quite rich.

## PRODUCTION.

The production of crude monazite sand in the United States during 1907 amounted to about 1,900,000 pounds, which averaged about 26 per cent monazite. This production, as in previous years, came entirely from North Carolina and South Carolina, the former State producing about five-sixths, and the latter, one-sixth of the total. The crude concentrates yielded 547,948 pounds of refined sand, averaging about 90 per cent of monazite and valued at $65,754, or 12 cents per pound. Of this production, North Carolina yielded 456,863 pounds, valued at $54,824, and South Carolina, 91,085 pounds, valued at $10,930.

The following table gives the production and value of monazite from 1893 to 1902, inclusive; of monazite and zircon in 1903; of monazite, zircon, gadolinite, and columbite in 1904; of monazite, zircon, and columbite in 1905; and of monazite and zircon in 1906 and 1907:

*Production, in pounds, of monazite in the United States, 1893–1907.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1893 | 130,000 | $7,600 | 1901 | 748,736 | $59,262 |
| 1894 | 546,855 | 36,193 | 1902 | 802,000 | 64,160 |
| 1895 | 1,573,000 | 137,150 | 1903 | [a] 865,000 | 65,200 |
| 1896 | 30,000 | 1,500 | 1904 | [b] 745,999 | 85,088 |
| 1897 | 44,000 | 1,980 | 1905 | [c] 1,352,418 | 163,908 |
| 1898 | 250,776 | 13,542 | 1906 | [d] 847,275 | 152,560 |
| 1899 | 350,000 | 20,000 | 1907 | [e] 548,152 | 65,800 |
| 1900 | 908,000 | 48,805 | | | |

[a] Including 3,000 pounds of zircon, valued at $570.
[b] Including the small production of zircon, gadolinite, and columbite.
[c] Including a small quantity of zircon and columbite.
[d] Including 1,100 pounds zircon, valued at $248.
[e] Including 204 pounds of zircon, valued at $46.

The production in 1906 was given for sand carrying only 80 per cent monazite. Estimating the quantity of the production on a 90 per cent basis for comparison with 1907, there were 752,155 pounds produced in 1906, with a value of $152,312. In 1907, as compared with 1906, there was a decrease of 204,207 pounds in quantity and of $86,558 in value. This large decrease in production is due to several causes, among which were the small amount of mining done by some of the companies as compared with 1906, and the closing out of one company in the first half of the year 1907. The lack of activity in mining was brought about by the continued low price of thorium nitrate, with a consequent drop in the price of monazite from 18 to 12 cents per pound for refined sand. To these causes was added, in the latter part of the year, the general stringency in the money market, necessitating very conservative action by many of the companies interested.

## IMPORTS AND EXPORTS.

According to the Bureau of Statistics, of the Department of Commerce and Labor, there were no imports of monazite or other thorium-bearing minerals into the United States during 1907. A considerable quantity of thorium nitrate, however, has been imported during the last six years. The quantity and value of these imports are given in the following table:

*Imports, in pounds, of thorium nitrate into United States, 1902–1907.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1902 | 42,815 | $131,350 | 1905 | 52,378 | $209,504 |
| 1903 | 64,520 | 232,155 | 1906 | 40,090 | 139,929 |
| 1904 | 58,655 | 249,904 | 1907 | 51,441 | 152,666 |

The imports of thorium nitrate in 1907 were greater than in 1906 by 11,351 pounds in quantity and $12,737 in value. This increase is not so large as might have been expected in view of the decreased production of monazite in the United States.

As in previous years, a portion of the monazite produced in this country was exported to Germany and England for manufacture.

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# PRECIOUS STONES.

By Douglas B. Sterrett.

## INTRODUCTION.

Interest in the mining in the United States of the more valuable of the precious stones, as the diamond, ruby, emerald, and sapphire, was keen during 1907. The announcement of the discovery and the statement of the incidents associated with the discovery of diamonds in Arkansas were made during the year by Messrs. Kunz and Washington. Development work on this diamond deposit was carried on and is still in progress. The ruby deposits of Cowee Valley, Macon County, N. C., were still further tested, and promising ruby in matrix specimens was reported as found. Prospecting for emerald at the emerald hiddenite mine in Alexander County, N. C., resulted in the discovery of promising gems, and it is expected that the locality will be developed on a larger scale in the near future. The output of sapphire in Montana, of both the rich blue and the varicolored gems, was very large. The blue sapphire is found in the matrix in a dike; the varicolored sapphire is found in placer deposits. At one locality the latter variety was mined with a dredge along with gold.

Several new localities and varieties of gems have been reported during the year. Among the new discoveries are deposits of topaz near Streeter, Mason County, Tex., and of beryl, tourmaline, garnet, and rose-quartz in Colorado. Among the new varieties of gems are benitoite, blue chrysoprase, serpentine cat's-eye, blue and green gold quartz, and smithsonite. Benitoite is a sapphire-blue colored stone found in San Benito County, Cal. Blue chrysoprase is copper-stained chalcedony, and has been found at Globe, Ariz. Serpentine cat's-eye has been found in Tulare County, Cal. It is gray to green serpentine with a silky luster, and gives a marked cat's-eye effect when cut "en cabochon." A new variety of gold quartz consists of native gold liberally sprinkled through copper-stained vein quartz. The new smithsonite is a translucent, apple-green variety found in large quantities in the Kelly mine, New Mexico. The color is similar to that of chrysoprase, though the gem is much softer.

Old gems appearing under new names are amatrice (utahlite matrix) and azurmalachite. Amatrice is the green, blue-green, and bluish variscite or utahlite cut with its associated matrix. The latter varies from white to gray, yellow, red, purplish, and brown in color, and the various combinations obtained in cut gems are quite pleasing. Azurmalachite is the name applied by Dr. G. F. Kunz to the copper carbonate gems from the copper mines of Arizona, and, as the name indicates, is a combination of azurite and malachite.

The precious-stones industry was in a flourishing condition during the first part of 1907. During the last half of the year, however, there was some depression in mining and the sale of gems. The native mining part of the industry was not so heavily affected as the part dependent on imported material.

## AGATE, MOSS AGATE, ETC.

Agate or chalcedony "clams" were reported from South Bend, Wash., by the Haberl Lapidary and Jewelry Company. Whether these are petrifactions or mammillary deposits the writer is not certain. They are said to contain globules of water. Several thousand pounds of moss agate were reported by Mr. W. C. Hart from the Hartville mining district of Wyoming. Dr. George E. Ladd reports the occurrence of agate and other chalcedony minerals in southeast Missouri. They occur abundantly in the residual soil over limestone formations, and some handsome specimens are found.

Mr. A. E. Heighway mentions the occurrence of agate, apparently of suitable quality and in sufficient quantity to be of commercial value, at two localities in the province of Santiago, Cuba. One of these is about 7 miles south of Bayamo; the other is about 2 miles southeast of Jibacoa, a town about 16 miles southeast of Manzanillo.

Comparatively few agate and chalcedony gems are cut or polished in the United States, the bulk of these minerals being cut at Oberstein, Idar, and other towns in Germany. The agate-cutting industry in Oberstein dates back to the fifteenth century, from which time it flourished until the close of the eighteenth century. With the exhaustion of the native deposits of agate, a decline followed until 1830, when new supplies were obtained from Brazil, and from that time until the present the industry has flourished, though scarcely any native agate is now used.

## AMAZON STONE.

The production of amazon stone came principally from Colorado, with a small quantity from Pennsylvania. In Colorado part of the output was obtained from the vicinity of Pikes Peak and part from Florissant, also in Teller County. Mr. J. D. Endicott reports the discovery in Custer County, Colo., of a new deposit of amazon stone, which has not yet been opened.

## AMBER.

### BURMA.

The production of amber from the Myitkyina district of Burma in 1906 was 217 hundredweight, valued at £709,[a] as against 126 hundredweight, valued at £945, in 1905. According to Consul-General W. H. Michael, of Calcutta,[b] the Burmese amber is in good demand. Its rich color, hardness, and the high polish it takes render it suitable for making into beads for rosaries and necklaces. Mining for amber by the Burmese is done in a crude way, and generally after the harvest work is completed. The men dig down, near places where amber has been found, sometimes to a depth of 45 feet; and then if no amber is found, a new trial is made elsewhere.

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.

[b] Daily Cons. Repts., July 26, 1907.

### GERMANY.

A large block of golden yellow amber, about 5 inches long, 4 inches wide, and 3 inches high, weighing 33 ounces, is reported to have been found on the beach at Thiessow, Pomerania.[a] It is said to be free from cracks or flaws.

### AMETHYST.

There was a small production of amethyst in 1907 from scattered localities. The largest output came from Nelson County, Va., with smaller quantities from Amherst County in the same State, Iredell and Macon counties, N. C., Rabun County, Ga., Fremont County, Colo., and Maine.

In Macon County, N. C., amethyst has been found at various places in the region of Tessentee Creek, near Scaly Mountain, and to the south of Highlands. In Rabun County, Ga., a few miles to the south of the last-named localities, amethyst has been found at several places within 2 or 3 miles of Clayton and from 12 to 15 miles to the east. The amethyst of this region occurs in veins cutting granite gneiss and mica gneiss. The veins in which the amethyst occurs are generally irregularly filled, well-defined fissures cutting the inclosing rocks at variable angles, though generally with a high dip. Some of these veins have been traced several hundred feet. Deep-colored amethyst crystals are found in pockets in these veins, often associated with pale amethystine and colorless quartz crystals. The spaces between the crystals are commonly filled with red clay or other earthy material. The pockets range from a fraction of an inch to 15 or 18 inches in thickness, and may extend several feet along the vein. The crystals range in size from a small fraction of an inch to 3 and 4 inches across. In some of the crystals the purple color of amethyst is entirely lacking or present only in pale shades. In others the rich purple of Siberian amethyst is present. The color is generally most intense near the points of the crystals and often occurs in planes parallel to the crystal faces. This renders only portions of the crystals suitable for cutting, although much amethyst and quartz suitable for specimens only is obtained.

The production of amethyst from Colorado was reported from a new deposit discovered by Mr. J. D. Endicott, of Canon City. This deposit is near Parkdale, about 13 miles west of Canon City. Mr. Endicott describes the vein as 30 inches wide, striking northwest, with a nearly vertical dip, through decomposed granite. The crystals of amethyst and amethystine quartz range in size up to 2 inches thick and 3 inches long.

### AZURMALACHITE.

The name azurmalachite has been applied by Dr. George F. Kunz to the gems cut from blue azurite combined with green malachite.[b] This form of gem is found in the copper mines of Bisbee and other districts in Arizona. The combination of minerals occurs in a variety of different forms, as concentric layers in stalactites, and as globular and botryoidal masses, etc. Various effects result from cutting in different directions through the masses, and attractive cuff buttons, scarf pins, hat pins, and other stones for less expensive jewelry are thereby obtained. Some of this gem was found at Yerrington, Nev., during 1907.

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[a] Manuf. Jeweler, April 2, 1908.

[b] Eng. and Min. Jour., August 17, 1907.

## BENITOITE.

Benitoite is a new gem mineral from California from the Mount Diablo range near the San Benito-Fresno county line. The gem has a blue color and was first mistaken for sapphire when discovered early in 1906 by Messrs. Hawkins and Sanders. The following notes are taken from a description of the physical and chemical properties of the stone by Messrs. George D. Louderback and Walter C. Blasdale,[a] and from a description of the geological occurrence by Ralph Arnold.[b]

Benitoite is regarded as an acid titano-silicate of barium with the formula $BaTiSi_3O_9$. It fuses quietly to a transparent glass at about 3, the fusing point of almandine garnet. Though practically insoluble in hydrochloric acid, it is readily attacked by hydrofluoric acid and dissolves in fused sodium carbonate. Its hardness is above 6, probably between 6¼ and 6½, and its specific gravity is 3.64–3.65. Benitoite crystallizes in the hexagonal system, trigonal division. The common forms observed are the basal plane, positive and negative trigonal pyramids, and corresponding prisms. The common habit is pyramidal, though occasionally the base is well developed and the crystal tabular. No tendency toward a prismatic habit was observed. The refractive index is a little above sapphire, or about 1.77 for the ordinary ray and 1.80 for the extraordinary ray. The double refraction is therefore strong. The color of benitoite varies from deep blue with a violet tint to pure blue of a lighter shade; small crystals are sometimes perfectly colorless. The color is not affected when the mineral is raised to a red heat.

The features of benitoite as a gem are its brilliancy, attractive colors, and strong dichroism, and its hardness is nearly equal to that of peridot or kunzite. The depth of color varies in different portions of many of the crystals, while the strong dichroism causes a variation of color depending on the direction the crystal is viewed. Light transmitted perpendicularly to the base is practically colorless, while that parallel to the base, or perpendicular to the principal axis, is blue. To secure the best effect, then, the gem should be cut with the table parallel to the principal axis and not to the base, which is contrary to the rule for sapphire.

Benitoite occurs in veins and pockets or geodes in a lens of basic schist inclosed in one of the largest serpentine areas of the Coast Range of California. The mineral is associated with natrolite and a black or brownish-black mineral, thought to be a new species and called carlosite. The lens of schist inclosing the benitoite veins is about 150 feet wide and at least 1,200 feet long, and cuts through a low serpentine hill with a strike of about N. 70° W. and a dip of 70° to 80° NE. The schist varies in color from dark greenish on the southwest border to bluish in the immediate vicinity of the gem-bearing veins near the middle of the mass. The bluish portion is an altered phase, and is often largely replaced by natrolite in contact with the veins. The altered portions of the schist are full of cracks and cavities varying in size up to 2 or 3 inches in width and roughly parallel to the planes of schistosity. The cavities are generally filled with natrolite, with or without benitoite or carlosite, or both. Natrolite is not always accompanied by benitoite, though benitoite has not been observed without natrolite. The associations of the minerals indicate that the crystallization of the benitoite and carlosite was previous to the complete deposition of the natrolite.

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[a] Bull. Dept. Geol. Univ. California, vol. 5, No. 9, July, 1907, pp. 149-153.
[b] Science, February 21, 1908, pp. 312-314.

Development work consists of a tunnel 50 feet long and several open cuts, the largest of which is 10 feet deep, 4 feet wide, and 14 feet long, following the strike of the schist. The gems are removed by pounding up the richer portions of the matrix and picking out the crystals or fragments remaining, or large crystals are chiseled out at the expense of the smaller ones. Since benitoite is rather brittle, a large percentage is lost in this operation.

As reported to the Survey, the production in 1907 amounted to about 15 pounds of rough benitoite, a large part of which was not suitable for cutting. Up to January 1, 1908, 350 carats of gems had been cut from this material.

## BERYL.

The production of beryl gems, as aquamarine, blue beryl, golden beryl, rose or pink beryl, and white beryl, was chiefly from California, North Carolina, Colorado, and Maine, with small amounts from New Hampshire, Pennsylvania, and Connecticut.

### CALIFORNIA.

The California output came from near Ramona, Mesa Grande, and Pala in San Diego County, and Riverside, Riverside County. Descriptions of some of the localities in San Diego County are given under the notes on the gem minerals of southern California (pp. 43–48). Mr. C. O. Johnson describes[a] the occurrence of new deposits of beryl about 2 miles east of Riverside at the base of the Box Springs Mountains. The beryls are of a good aquamarine color, some approaching the emerald in depth of color. The best material was found on the land of F. D. Mears in a pegmatite formation cutting diorite or gabbro. Dark-green colored mica is also found with the beryl, but not lepidolite, as generally occurs in the gem-bearing pegmatites of southern California. About 20 pounds of rough material, part suitable for cutting, was obtained before development work was stopped through financial troubles.

### COLORADO.

Beryl from Colorado was reported as aquamarine, chiefly from the gem mines in Royal Gorge and Mount Antero, Chaffee County, by C. A. Beghtol & Co. Mr. J. D. Endicott reports the discovery of four deposits of aquamarine-colored beryl, some suitable for cutting, associated with rose quartz, about 6 miles north of Texas Creek, Fremont County.

### IDAHO.

Mr. Ernest Schernikow, of New York, reports the finding of two good blue beryl crystals near Lewiston, Idaho. These crystals were obtained from an Indian squaw who would not reveal their source.

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[a] Personal letter, dated April 24, 1906.

## NORTH CAROLINA.

Regular mining for aquamarine and the beryl gems was carried on in North Carolina during 1907 at Hiddenite. Scattered lots were brought in by mica miners and prospectors in other parts of the mountain country, chiefly in Mitchell and Yancey counties, though some were obtained in Iredell County and at Barretts Mountain, Alexander County.

The hiddenite and emerald mine, one-half mile west of Hiddenite, Alexander County, was reopened and worked during part of the year by Mr. Cary Wright for the American Gem Mining Syndicate. At the same time Mr. Wright opened a new prospect called the Ellis emerald mine, one-fourth mile east of Hiddenite. The work was stopped in September, 1907, pending the installation of a power plant for larger operations. Aquamarine and beautiful specimen beryl, emerald, and hiddenite were obtained in promising quantities. Mr. Wright mentions one beautiful specimen of beryl, 2 inches long by 1½ inches in diameter, weighing over 750 carats, from the emerald-hiddenite mine. It was translucent with prism faces highly polished. Many aquamarine crystals of from 10 to 20 carats were found in the same mine. Several fine crystals of aquamarine were found at the Ellis mine, two of which were embedded in transparent quartz crystals, making splendid cabinet specimens. Emeralds of fine color were obtained from both mines. At the Ellis mine one dark-green emerald weighing 276 carats was found. About 200 carats of hiddenite were obtained from the emerald-hiddenite mine. One crystal, weighing about 10 carats, was one-half colorless and the other half a deep emerald green. Jet black tourmaline crystals associated with feldspar; clear, colorless, smoky, and rutilated quartz crystals; rutile crystals, etc., were also found associated with the beryls.

At the emerald-hiddenite mine there are a large number of veins generally striking north of east with high dips to the north. For a distance of over 50 yards both to the north and to the south of the main workings a number of pits and several shafts have been made on different veins. In all of the veins opened quartz crystals were found, some very clear and beautiful, with well-developed crystal form. Some of these openings yielded beryl or hiddenite, occasionally of gem quality.

The old workings at the emerald-hiddenite mine were made chiefly between 1880 and 1885, and consisted of a large open cut, with two shafts near the western end, besides numerous smaller test pits in the vicinity of the open cut. The open cut is situated near the top of a low ridge and is probably 150 feet long, 20 to 40 feet wide, and 15 to 20 feet deep. A haulway had been cut to the same level at the east end to the dump. The new work in 1907 consisted of an open pit, some 12 feet wide and 18 feet long, near the eastern end of the old cut and at the north side of the haulway. Two well-defined veins were found in this cut, and also two less promising ones. These veins were nearly parallel, and the strike measured on the best one was N. 70° E., dip about 85° N. Several good, though small, pockets were found in this cut.

The country rock in the region around the emerald-hiddenite mine and the Ellis emerald mine is chiefly biotite gneiss, garnetiferous in places, which has been much compressed and folded, probably while in a plastic condition. Veinlets of quartz in the original rock have been folded and crumpled during this compression into forms resembling folded ribbon. The country rock in the neighborhood of the veins has been highly silicified by the addition of much quartz. This quartz along with other minerals, as muscovite, rutile, pyrite, etc., has replaced the biotite and feldspars and other minerals of the country rock. This replacement was later than the compression of the rock and about contemporaneous with the deposition of the vein matter. These phases are beautifully illustrated in hand specimens which show typical biotite gneiss with folded quartz veins, several feet from a vein, and in similar rock, highly silicified, with a portion of the vein-filling adhering. In the latter specimen the vein filling a fissure is glassy quartz with calcite, rutile, and pyrite inclusions. The wall next to the vein consists largely of granular quartz and an emerald-green (chrome) muscovite, with a little rutile and pyrite. At about 1 inch from the vein the replacement of the country rock is not so complete, and biotite becomes gradually prominent in the rock. At 2 inches from the vein the rock is nearly black biotite gneiss, rich in quartz. A folded quartz veinlet cuts the gneiss to the vein wall. It is more prominent in the black gneiss than in the highly replaced gneiss, though it can readily be traced through the latter, since the quartz of which it is composed was not so easily replaced as certain constituents of the gneiss. Some of the rock cut by the veins contains much chlorite and has a yellowish-green color.

The material filling the gem-bearing veins consists of quartz, calcite, dolomite, muscovite, rutile, black tourmaline, aquamarine and emerald beryl, hiddenite, pyrite, chalcopyrite, and monazite. All of the veins in the neighborhood do not contain all of these minerals, but each of the numerous veins exposed in the workings contain some or all of them. In the cavities all of these minerals occur in crystals; in solid-vein matter certain ones only have crystal form. The calcite was introduced after the other minerals had been deposited, in many places filling up previously existing cavities. Crystals of the other minerals are embedded in solid calcite veins, and calcite has been deposited between broken fragments of beryl and other crystals. Rutile suitable for cutting is plentiful in brilliant crystals, some long and slender, others short and thick. The crystals are commonly twinned, several crystals often joined or crossing each other at angles of 60°, forming beautiful cabinet specimens of rosettes or reticulated masses of needles. The gem minerals—emerald, aqamarine, and hiddenite—occur in distinct crystals in the veins, and when lining the walls of cavities and of good color they make a beautiful contrast with the associated gangue minerals.

The vein at the Ellis emerald mine is pegmatite, with cavities and pockets included in it. The pegmatite strikes N. 50° E., with a high northerly to vertical dip. There are stringers or arms of pegmatite along the walls, and at one place the pegmatite is composed along one side largely of small mica blocks. The country rock is biotite gneiss, small dikes of quartz diorite being included. The latter weathers out in rounded bowlders or "nigger heads," which are scattered over the surface near the mine. The quartz in portions of the pegmatite is a fairly dark rose color. So far, however, none suitable for gem purposes has been found.

## CALIFORNITE.

Californite is a compact variety of vesuvianite with color and texture so like jade that it was at first mistaken for that mineral. It is found in Siskiyou County, Cal., on the south fork of Indian Creek, 12 miles from Happy Camp, and has been described by Dr. George F. Kunz.[a] Two other localities are known where californite has been found in Tulare County, Cal. One of these was described in this report for 1906. During 1907 there was a considerable production of californite by the Himalaya Mining Company from its mine in Siskiyou County.

## CAT'S-EYE OR TIGER-EYE.

### CALIFORNIA.

*New variety.*—A specimen was received at the Survey from Mrs. Gertrude S. McMullen, of the Southwest Turquoise Company of Los Angeles, Cal., which seems to be a new species of cat's-eye or tiger-eye. The mineral is a compact variety of serpentine, sufficiently fibrous to have a silky luster, though not readily separated into fibers like asbestos. The hardness is about 4.5. The color is opaque gray with the grain and dark green across it. A cabochon stone cut with the grain gives an excellent play of light across the rounded surface as the stone is rocked. The bar of light reflected from the middle of the stone is greenish gray, while the color on the sides at the ends of the fibers is dark green. The beauty of the gem is somewhat marred in some specimens at least by frequent irregularly shaped bars and tubes of yellowish mineral, apparently also serpentine, running for some distance through the massive material and parallel to its fibers. If the mineral is found without these yellow markings, as it doubtless will be, very attractive stones for scarf pins, pendants, etc., could be cut from it. This mineral is found in Tulare County, associated with asbestos and other serpentine. It might appropriately be called California cat's-eye or tiger-eye, if no other name has been given to it.

## CHRYSOPRASE AND BLUE CHRYSOPRASE.

### CALIFORNIA.

There was a large production of chrysoprase from the mine of the Himalaya Mining Company, in Tulare County, Cal. Some of this material is of beautiful color and is suitable for high-grade jewelry. It is used also for handsome ornamental effects, as in mosaics, etc.

### ARIZONA.

Specimens of blue and bluish-green copper-stained chalcedony were received from Mr. H. P. Wightman, of Globe, Ariz. The mineral occurs in small stringers in the Keystone copper mine in that district. The copper ore at this mine is said to be principally chrysocolla or silicate ore. The chalcedony varies in color from bright to pale blue, bluish green, and nearly apple green, and is more or less translucent. In some pieces the color occurs in curved layers and varies in intensity, thus bringing out the mammillary structure of chalcedony in peculiar wavy markings. In other pieces the color approaches that of chrysoprase, or resembles that seen in certain artificially colored chalcedony. Mr. Wightman reports a sale of probably 200 pounds of selected mineral during 1907 by the miners in Globe. After cutting, this blue chrysoprase brings locally from $3 to $10 a piece for the best grades.

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[a] Jewelers' materials and ornamental stones of California: California State Min. Bur. Bull. 37, 1905, pp. 93-95.

## DIAMOND.

### UNITED STATES.

*Arkansas.*—The work of testing the Arkansas diamond deposit continues quietly. A brief report on the locality was prepared by Philip F. Schneider[a] for the Arkansas Bureau of Mines.

The latest authoritative information on the Arkansas diamond deposit has been given by Messrs. Kunz and Washington in a paper before the February meeting, 1908, of the American Institute of Mining Engineers in New York. The general geology of the area and the petrography and weathering of the peridotite are described as they were in a paper by the same authors incorporated in this report for 1906. In tests made with a diamond drill the peridotite was proven to depths of 80, 186, and 205 feet. The green and yellow grounds underlying the layer of black, sticky "gumbo" soil were found to extend down 40 feet in places and are estimated to average 20 feet in depth over the area. The outcrop of the peridotite is estimated to cover about 40 acres, though it may be found larger after further exploration.

General conditions concerning future work are briefly discussed. Water supply, timber, and coal are available, and labor and transportation facilities can probably be satisfactorily arranged. Some 140 diamonds have been found, with an aggregate weight of about 200 carats. The largest stone weighs less than 6½ carats, though the average size compares favorably with the general run of most of the South African diamonds. There is a large proportion of white stones, many of which are free from flaws and are very brilliant. Some of the yellow diamonds are also of exceptional quality and color. The genuineness of the occurrence of the diamonds in their matrix is reiterated, and the occurrence of one stone embedded in the green ground at a depth of 15 feet is cited to strengthen the conclusion. The quantity of green ground that can be readily washed is large. Portions of the peridotite on the borders of the outcrop are in such hard masses as to indicate that it will not readily decompose. The sludge and cores from the diamond drill tests, however, show a badly altered rock at depth at many places, and suggest that much of the peridotite from depth will readily disintegrate on exposure to the weather. Some fresh hard peridotite will be encountered, as in the South African mines, and will probably have to be treated with a certain amount of crushing. Warning is given against the unscrupulous who will probably claim to have located new peridotite areas "on the same lead" or "an extension" of the present one. It is pointed out that since this peridotite has the form of a pipe its outcrop will be limited to one place. Even should new areas of this rock be located, and should their nature be proven by an examination of a petrographer, it will still be necessary to prove the presence of diamonds and in paying quantities. Peridotite rocks are not uncommon, though few are known to be diamond bearing.

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[a] Schneider, Philip F., A preliminary report on the Arkansas diamond field: Arkansas Bur. Mines, Manufactures and Agriculture.

*California.*—Frequent reports have appeared in the newspapers concerning the prospecting for diamonds near Oroville by Mr. M. J. Cooney. It appears that washing machinery and more land are to be purchased and extensive prospecting is to be carried on. Besides the occurrence of a rock claimed to be identical in appearance with the kimberlite of South Africa, reports state that diamonds have been found associated with that rock. Authentic finds of diamonds in this section of Butte County are recorded,[a] especially at Cherokee above Oroville. These diamonds have come from alluvial deposits, however, and were generally found in washing for gold. Up to the present time no authenticated discovery of diamond in its original matrix in California is recorded. During the early part of 1907, specimens of serpentinized rock called "kimberlite" from the supposed diamond pipe were kindly sent to the Survey by Mr. Cooney. These specimens were discussed in this report for 1906. Upon careful examination and comparison with typical kimberlite from South Africa, it became evident that the Oroville rock was quite different from true kimberlite.

*Kentucky.*—Newspaper reports have appeared telling of the discovery of diamonds in Kentucky during 1907, though no authenticated finds are recorded.

According to the report of Mr. H. A. Millar, secretary of the Kentucky Diamond Mining and Developing Company, the complete diamond washing plant installed by that company on Creech's Creek in Elliott County was operated during the latter part of the summer and in the early fall. Overburden was removed from three portions of the kimberlite rock outcrop, and some of the yellow ground was washed. Delays were caused by the breaking of the gearing, and operations were finally closed for the winter on the 22d of October, when the water supply for washing was exhausted. Though a total of 2,825 loads of 18 cubic feet were washed without finding diamonds, operations were to be resumed in the spring of 1908.

## SOUTH AFRICA.

*Griqualand West.*—According to the nineteenth annual report of the De Beers Consolidated Mines,[b] the number of loads of "blue" raised and washed and the quantity and value of diamonds obtained again showed large increases. The total production of blue ground at all the mines—De Beers, Kimberly, Wesselton, Bultfontein, and Dutoitspan—was 9,010,686 loads, as against 8,144,979 loads in 1906, and the total quantity washed was 6,626,291 loads, as against 5,625,592 loads in 1906. This leaves a remainder of 9,391,603 loads on the floors, as against 6,769,126 in 1906, an increase of 2,622,477 loads. The number of carats of diamonds won from all the mines and from the tailings and débris was 2,619,872, as against 2,213,991 carats in 1906. The increase in the number of diamonds won came from the Wesselton, Bultfontein, and Dutoitspan mines, and from the increased quantity of tailings washed. The average yield per load was slightly less in 1907 than in 1906 for all of the mines except the Wesselton, which showed an increase. The average yield of all of the mines in 1907 was 0.3125 carats per load, as against 0.3250 carats in 1906. The average value per carat was greater in the Bultfontein, De Beers, and Kimberly mines, and less in the Wesselton and Dutoitspan. In the Wesselton mine alone was the average value per load greater in 1907 than in 1906. The total quantity of "blue" in sight above the lowest levels of the mines and on the floors was 57,409,013 loads, as against 64,315,580 loads in 1906. The deepest workings were in the Kimberly mine, where the main shaft was down 2,599 feet; the hoisting was done from the 2,520-foot level. At the De Beers mine hoisting was done from the 2,040-foot level, though the deepest shaft was 2,466 feet. Hoisting from the other three mines was all done from a depth of less than 1,000 feet.

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[a] Turner, H. W., Diamonds in California: Am. Geol., vol. 23, 1899, pp. 182-191.

[b] Nineteenth Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1907.

The sale of diamonds realized £6,452,597, as against £5,607,718 in 1906. The net profits were £2,607,240. Dividends amounting to £2,550,000, or £750,000 more than in 1906, were distributed, and a balance of £932,624 was brought forward. The buying syndicate took diamonds valued at about £1,000,000 more than the minimum limit contracted. Up to November of 1907, however, only the minimum limit called for by the contract had been bought. Finding that there was to be no relief from the heavy income tax, amounting to nearly £100,000 annually, imposed by the British Government, the De Beers Company voted to transfer from London to South Africa its office controlling operations at the mines. The London tax would have been an especially heavy burden, since the company will probably have a 10 per cent tax on profits to pay to the Cape government also.

*Transvaal.*—The production of diamonds in Transvaal [a] during the fiscal year 1907 amounted to 1,545,336 carats, valued at £2,203,511, an increase of 786,930 carats and of £1,235,282 over 1906. The production was chiefly from six volcanic pipe mines, the alluvial diggings at Christiana contributing only 2,562 carats, valued at £13,579. The Premier mine was the principal producer, having perfected its mine equipment. Several million loads of ore can be handled a year at this mine, and a regular and adequate water supply and a satisfactory method of disposing of tailings and slums have been provided.

*Orange River Colony.*[b]—The production of diamonds in the Orange River Colony during the fiscal year ending June 30, 1907, is given by Mr. Burnet Adams as 398,703 carats, valued at £1,221,202, as compared with a value of £902,727 in 1906. The increase comes chiefly from the two new mines—the Roberts-Victor and the Voorspoed. Other mines producing were the Jagersfontein, Koffyfontein, Lace, Monastery, and the alluvial diggings. The yield of the alluvial diggings was 7,103 carats, valued at £36,895, while the matrix mines produced 391,600 carats, valued at £1,185,308. The price per carat of the alluvial diamonds is about 43 per cent higher than of those from the pipe mines. The production for the calendar year 1907 is given for the Roberts-Victor mine [c] as 123,427 carats, an average of 0.536 carat per load, and for the Voorspoed as 40,653 carats, an average of 0.21 carats per load.

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[a] Ann. Rept. Govt. Min. Eng., Transvaal, 1907.
[b] Mines Dept. Orange River Colony, Fourth Ann. Rept., 1907, Bloemfontein.
[c] Mining Jour., London, February 1, 1908

*Vaal River diamonds.*—The terraces and river gravels along the Vaal River from Bloemhof, in Transvaal, to its junction with the Orange River in Griqualand West, a distance of about 200 miles, have been worked for diamonds.[a] The deposits vary from a few inches to 40 or 50 feet in thickness, and in some cases extend 3 or 4 miles laterally from the river. The gravels consist of a large number of greenstone bowlders filled in with sand and pebbles, and resting on a flow of amygdaloidal greenstone. The pebbles are chiefly siliceous, as jasper, chalcedony, agate, etc., and with them are associated pebbles of greenstone, ironstone, ilmenite, garnet, topaz, and diamond. There has been more than one period of sedimentation, and the gravels of the most recent period have a matrix of stiff siliceous clay. The diamonds have been found almost everywhere through the gravel deposits, there being no reliable geological indications as to their occurrence. The placer diamonds, taken collectively, are probably the finest stones obtainable in South Africa. They occur more commonly in dodecahedral crystals and are singularly free from flaws. Stones with a yellowish tint are predominant, though all colors are found. The value is estimated at about £6 per carat for all diamonds sold to buyers along the river.

## SOUTH AMERICA.

*Brazil.*—The diamond and carbon mining industry of Brazil is increasing. Consul-General George E. Anderson, of Rio de Janeiro, reports that dredges[b] have been installed along the Jequitinhonha River, in the State of Minas Geraes, and that large amounts of American capital are being invested in the Diamantina country. The work on the mines in the latter region has necessitated the building of a highway from the end of the railroad at Curalinho. This work is under the direction of an American engineer and will be carried out by American methods. Heretofore the shipments of Brazilian diamonds have been to Europe, though it is likely a number of them will be made to this country direct, now that American capital is so heavily interested.

It is difficult to obtain information on the production of Brazilian diamonds, since large quantities were smuggled out of the country to avoid the payment of the 5 per cent export tax. Consul-General Anderson, in the report quoted above, gives the value of diamonds registered for export during 1906 as $310,000. This is said to include the carbons or black diamonds from Bahia. That the official export figures do not adequately represent value of the production is shown by the figures given in a report by former Vice-Consul J. P. W. Rowe,[c] of Bahia, in which it is estimated the annual exports from that State amount to over $4,000,000. The State government of Bahia found that it failed to receive the proper revenue due from the 7 per cent export tax, and accordingly abolished the export-tax law in favor of another. Each merchant or dealer shipping diamonds or carbons was to be charged an amount calculated to bring the revenue up to what it should have been under the 7 per cent export-tax law. The new law was met by the combining of many dealers and their shipping as one firm.

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[a] Park, Mungo, Vaal River, South Africa, diamond fields: Mining Science, March 19, 1908.
[b] U. S. Daily Cons. Repts., January 20, 1908.
[c] U. S. Daily Cons. Repts., January 7, 1908.

*British Guiana.*—The output of diamonds in British Guiana is chiefly in small sizes. The government report for the year ending June 30, 1907, shows a production[a] of 65,903 stones, weighing 4,718 carats. The change from the preceding year was not large, though in 1904–5 the output was 175,400 diamonds, weighing 10,619 carats. An idea of the value of British Guiana diamonds may be gained from the exports between January 1 and September 18, 1907,[b] which are placed at 1,564 carats, valued at $12,370.

### INDIA.

The production of diamonds in India[c] is given for 1906 as 305.9 carats, valued at £5,160, as against 172.4 carats (valued at £2,474) in 1905. The increased production came chiefly from Panna, where the value of output was £4,348. The remainder of the production came from the states of Charkhari and Ajaigarh.

### NEW SOUTH WALES.[d]

The total production of diamonds in New South Wales between the years 1867 and 1906 is given as 157,137 carats, valued at £104,089. The largest productions recorded were in the years 1899 and 1904, being 25,874 carats valued at £10,350, and 14,296 carats valued at £11,620, respectively. The production for 1906 was considerably smaller and amounted to 2,827 carats valued at £2,120.

### DIAMOND INDUSTRY.

The consumption of diamonds in the United States is ordinarily large and amounts to over one-half of the world's production. With the immense falling off in purchases of diamonds in the United States caused by the financial depression in 1907 and reduced sales in other countries, the diamond industry has had to face a serious situation. The decreased demand for diamonds has affected all branches of the industry. Large numbers of cutters, not only in the United States but also abroad, have been without employment for several months. Several diamond mining companies have been forced to close their mines or limit their output. At one time it was rumored that the price of diamonds would fall when the agreement of the De Beers and Premier diamond mining companies with the diamond buying syndicate expired in the latter part of March, 1908. The reduction of price by one large company would have precipitated a war of low prices with the other, and this would have ruined those dealers with large stocks of high-priced diamonds on hand. The six months' agreement made in 1907, by which the diamond buying syndicate was to purchase the output of the Premier mine at a certain value proportional to that paid for the De Beers output, was not renewed after expiration in March, 1908. Frequent assurances, however, have been given to diamond dealers and merchants by both the De Beers and Premier mining companies and the diamond buying syndicate, that the price of diamonds will be maintained under all circumstances.

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[a] Mining World, April 18, 1908.
[b] Mining Jour., London, October 12, 1907.
[c] Rec. Geol Survey India, vol. 36, pt. 2, 1907.
[d] Ann. Rept. Dept. Mines, New South Wales, 1906, p. 53.

*Cullinan diamond.*—The great Cullinan diamond was presented to King Edward of England on his birthday, by the people of Transvaal as a demonstration of loyalty and high regard. This diamond is now being cut to be placed among the crown jewels of England. In the rough the Cullinan diamond weighed nearly 3,025 carats, or about 1.37 pounds avoirdupois, and was found in the Premier mine, Transvaal, in January, 1905. The cutting and polishing of this huge diamond is being carried on by the firm of Joseph Asscher & Co., in Amsterdam, and will probably not be completed before the end of 1908. According to Mr. Louis Asscher,[a] of the Asscher firm, the cleaving of the diamond was very successfully accomplished by Joseph Asscher, who split it through a defective spot, part of which was left in each portion of the diamond. The diamond was cleft by making an incision half an inch deep with a sharp diamond point in the proper place and then striking a specially designed knife blade placed in the incision a heavy blow with a piece of steel. Apparatus specially designed for polishing the diamond has been constructed as a dop 6 inches across and weighing about 20 pounds, which is raised mechanically from the polishing disk. The latter is about 16½ inches across and makes 2,400 revolutions per minute. Diamond dust mixed with oil will be used in large quantities in polishing the stone. The larger portion will probably be cut into a drop-shaped stone weighing between 500 and 600 carats when completed. The other portion will be cut into smaller stones, one of which, even then, will be one of the large diamonds of the world. Extreme precaution is taken to guard the diamond at all times, both by the use of numerous watchmen and by combinations of safes.

*Hope blue diamond.*—The famous "Hope" blue diamond has been sold by Joseph Frankel's Sons of New York. The buyer is Señor S. I. Habid,[b] a Spanish collector in Paris, and the price was about $400,000. The "Hope" diamond is a beautiful blue, very brilliant stone weighing 44¼ carats, believed to be a part of the wonderful blue diamond, weighing 112 carats, brought from India by Tavernier in 1642 and sold to Louis XIV. A century later this diamond was cut into a triangular shaped stone weighing about 67 carats. In 1792 it was stolen, and no trace was ever discovered. In 1830 three blue diamonds, of the same color and quality as the Tavernier stone appeared on the market. The aggregate weight of these three diamonds was less than that of the stolen French jewel by an amount which would naturally be lost in cutting. The largest stone was purchased by Henry Thomas Hope, from whom it was named. After Mr. Hope's death the diamond was purchased from the heirs by Joseph Frankel.

*Metric carat.*—The weight of the carat used in different parts of the world is quite variable, ranging from 188.5 milligrams in Boulogne to 213.3 in Turin and to 254.6 in Arabia.[c] The weights most used, however, fall between 205 and 207 milligrams. The advantages to be gained by the use of a standard carat for all countries bearing a simple relation to other standard weights can readily be seen. The metric carat, of 200 milligrams, answers this purpose well and is not greatly different from the carat used by several countries. With the acceptance by the international committee of weights and measures and the sexennial conference of the metric convention,[a] the metric carat is a legal weight in all countries using the metric system of weights and measures.

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[a] Jewelers' Circ. Weekly, May 20, 1908.
[b] Manuf. Jeweler, May 21, 1908.
[c] Valentine, E. J., The carat weight: Mining Science, April 30, 1908.

*Artificial diamonds.*—Much interest has been manifested in the case of Sir Julius Wernher, of the De Beers Company, against a French engineer, Henri Lemoine, who claimed to manufacture diamonds by a secret process. In 1904 Lemoine succeeded in interesting Sir Julius in his process, and when its genuineness was apparently established a contract was drawn up. Under the conditions of this contract Lemoine was to receive a large sum of money for his invention, which was to remain secret until his death, and all diamonds made were to be turned over to Sir Julius. A description of the process of manufacture was placed in a sealed envelope and deposited in the Union of London and Smith's Bank, where it was to remain until Lemoine's death and then to become the property of Sir Julius. It is said that over $300,000 were advanced to Lemoine for a factory and apparatus, and for this sum, or part of it, Sir Julius brought suit, since he no longer had faith in Lemoine's process. During the trial Lemoine asked for an opportunity to give a demonstration, and during April, 1908, was released on bail for this purpose. After making elaborate preparations he not only failed to produce artificial diamonds but forfeited his bail and fled. The sealed envelope was opened and was found to contain a jumble of recipes of no value.

## EMERALD.

### NORTH CAROLINA.

Emerald was obtained from three places in North Carolina during 1907. The greater part came from the emerald-hiddenite mine and the Ellis emerald mine, already described under beryl. Of the remainder, part was found at a prospect belonging to Mr. W. H. Warren, 1 mile north of Hiddenite, and part consisted of emerald matrix from Mitchell County probably mined some years ago and recently cut.

### COLOMBIA.

A few notes on the famous emerald mines of Muzo, Colombia, are given in a letter from Bogota, based on the report of the German minister to his government, in the New York Herald.[b] The mines are now leased to a Colombian syndicate for a period of five years, under rigid government supervision. The Government expects to work the mines on its own account when the present lease expires. The mines are on the side of a steep mountain about 350 feet above the mining village. Formerly the Spaniards worked them for emeralds by driving adits into the hillsides; now they are operated by open cut work with terraces. The rock is broken into smaller and smaller fragments by peons, who pick the gems out from washing troughs.

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[a] Comptes rendus des séances de la quatrième conférence générale des poids et mesures, Paris 1907, p. 60.

[b] Jewelers' Circ. Weekly, November 13, 1907.

A plentiful supply of water is obtained from the mountains for washing purposes, and the débris is washed down to the Rio Minero. Over 100 persons are employed at wages of about 25 cents a day with food, shelter, and medical attendance free. The workmen are protected from the sun by canvas awnings and palm leaf shelters. Even then the temperature in the pit reaches 115° to 120°, and the air is excessively humid. The peons are carefully watched, and every stone is turned over to inspectors as soon as it is found. The latter clean the gems and report to the government officials. At least $1,000,000 worth of emeralds were mined and sold during 1906.

## GARNET.

Several varieties of gem garnets were produced during 1907, and from several States. The most important were the hyacinth garnets, spessartite, and essonite, which were obtained chiefly from California, though Mr. Don Maguire, of Ogden, reported a large production of rough spessartite from San Juan County, Utah. Much of the hyacinth came from the foothills in the desert near Dos Cabezas Springs, San Diego County, Cal., where the San Diego Gem Company owns ten claims. The remainder came from the gem mines near Ramona and Mesa Grande, Cal.

Mr. W. P. Dorsey sent in specimens of hyacinth garnets found by him near Silver City, N. Mex. They were small, clear, trapezohedral crystals with a rich yellowish-red to brown color. The crystals varied from pin-head size to 3 or 4 millimeters in diameter, and will furnish beautiful gems if larger ones are found. The garnet crystals were associated with quartz crystals in the specimens, both appearing to line cavities in a feldspathic rock impregnated with garnet and quartz.

A quantity of pyrope garnets were collected from the Indian reservations in northeastern Arizona and northwestern New Mexico. Mr. J. L. Hubbell, of Ganado, Ariz., mentions a locality about 75 miles west of north of Ganado where garnet is found abundantly over a stretch of country about 10 miles long. The garnets are picked up from the surface of the ground by the Indians. They occur in a sandy soil and are uncovered by the action of the wind.

Mr. Samuel Scott, of Custer, S. Dak., reports the occurrence of beautiful red garnets 4 miles west of Custer in Elephant Gulch. These garnets were obtained while mining for placer gold, and the flawless ones were sold as gems at from 10 cents to $5 each.

The majority of the garnets are found in well-developed dodecahedral crystals with smooth faces. Small garnets, the size of a grain of wheat, are abundant, but stones suitable for cutting into large gems are rare. Some of the smaller garnets are saved by the miners and sold in small vials to tourists.

Mr. J. D. Endicott reports the discovery of a band of mica schist carrying almandine garnets, near Canon City. Some of these garnets are as much as 1½ to 3½ inches in diameter. They have a rich red color, and some have portions that are clear and free from flaws. About 10 pounds of stones fit for cutting into small gems were obtained at this locality during 1907.

## GOLD QUARTZ.

A new variety of gold quartz from the Quartet mine, Searchlight, Nev., has been cut into small articles, such as watch charms, etc., by Mr. William Petry, of Los Angeles, Cal. A small specimen, kindly sent to the Survey by Mr. Petry, contained much bright yellow free gold in irregularly shaped particles and flakes in and between the grains of granular quartz. Most of the quartz appears bright green from the presence of films and small masses of malachite between the grains. The specimen also contained patches of purplish stains which could not be identified. The combination of colors makes an attractive small ornament, though the presence of malachite with quartz may give trouble in producing a high polish.

## JADE.

### BURMA.

The production of jade (jadeite) in the Myitkyina district of Upper Burma during 1906 amounted to 2,214½ hundred weight.[a] This was less than in 1905, owing to scarcity of labor. The exports of jade, through Rangoon, however, were greater and amounted to 2,566 hundredweight, valued at £64,433, in 1906, as against 2,342 hundredweight, valued at £43,474, in 1905. In 1905 there was a further export of 343 hundredweight, valued at £2,000, overland to China.

## JASPER.

There was a production of jasper in Colorado and southern California during 1907. Mrs. Gertrude S. McMullen, of the Southwest Turquoise Company, of Los Angeles, mentions a vein of jasper in San Bernardino County, Cal, from which a specimen was sent to the Survey. This deposit is owned by the Cracker Jack Bonanza Gold Mining Company. The jasper has a dark-red brown or liver color, and is mottled with many small gray streaks. The mottled effect is due to a former brecciation of the jasper, with a subsequent cementation by chalcedony. Some of this jasper has been polished by the Southwest Turquoise Company, and furnishes handsome small ornamental objects, though the color is rather dark and of course the mineral is expensive to polish since it is so hard.

Good jasper is known to occur in the eastern part of San Diego County, Cal., and from this region jasper was obtained during 1907. The Native Gem Mining Company reports that abundant material can be obtained from its mine. Mr. John F. Schwartz, of San Diego, describes some of the jasper from Dulzura, San Diego County, as very handsome; but he makes the same statement as do others who have handled the California jasper, that it is so hard to cut as to render it doubtful whether the deposits will be worked commercially.

Mr. Louis J. Deacon describes the occurrence of smooth, waterworn pebbles of brick-red, brown, and yellow jasper, associated with quartz pebbles and occasional jet black flinty quartz, on the Delaware Bay beach at Cape May, N. J. The occurrence is similar to that of the "pebble beach" of Redondo, Cal. Both at Redondo and at

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.

Cape May visitors spend much time searching for pebbles suitable for cutting or for specimens. Mr. A. C. Keck describes the occurrence of very fine red and green jasper pebbles with chalcedony and other gems at Redondo. The chalcedony is cut and sold as moonstone, and the jasper as bloodstone and sardonyx.

## OPAL.

### UNITED STATES.

A small quantity of opal was reported from Oregon, California, Colorado, and North Carolina. That from Oregon was probably from the deposit in the eastern part of the State, a few miles below the town of Durkee, described by Dr. Kunz[a] as occurring in cavities in rhyolite tuff. The opal from California came from the deposits in San Bernardino County, about 20 miles northwest of Barstow. Small pieces of precious opal and handsome specimen and ornamental material have been found here. Some of the latter variety obtained by Mr. C. O. Johnson is described[b] as dark red jasper streaked with semi-opal. Mr. J. D. Endicott reports the discovery of lechosos or milky opal in the water-worn gravels in the foot-hills south of Canon City, Colo. Opal in North Carolina was limited to one specimen of lechosos or milky opal found in the southern part of Iredell County by Mr. J. T. Cashion.

### NEW SOUTH WALES.

The production of opal in New South Wales is still largely from the White Cliffs division.[c] New grounds have been opened in the neighborhood of White Cliffs and near Bunker, or Gemville. The ranges along the White Cliffs are still unprospected, though it is thought they contain rich deposits of opal. There was an increase in production from Wallangulla and Lightning Ridge, in Walgett division. The production of opal from 1890 to 1906 is given as £989,099. The largest productions were £135,000 in 1899 and £140,000 in 1902. The production for 1906 amounted to £56,000, of which about £50,000 came from White Cliffs.

### HUNGARY.

The opal mines of upper Hungary were advertised in 1907 for lease for a period of ten years[d] or longer, or to be sold by the Government. At the same time about 30,000 carats of polished precious opal deposited with the exchequer was to be put up for sale.

## PERIDOT.

Peridot was produced in 1907 in the northeastern part of Arizona and the northwestern part of New Mexico. The output came, as usual, chiefly from the Indian reservations, where the stones were gathered by the Indians and traded at different points. Mr. J. L. Hubbell reports a quantity of peridot gathered from the surface on the Ziltsusayan Butte, about 20 miles northeast of Ganado, Ariz.

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[a] Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 1247.

[b] San Diego News, January 23, 1908.

[c] Ann. Rept. Dept. of Mines, New South Wales, 1906, p. 53.

[d] Mining World, May 18, 1907.

## PETRIFIED WOOD.

Petrified wood occurs at a number of localities in the Western States. Mr. W. C. Hart reports the sale of some 5,000 pounds during 1907, obtained from El Paso County, Colo. Mr. Samuel Scott reports that agatized and jasperized wood is plentiful in the Dakota sandstone formation around the Black Hills. This material is not used at the present time. The beautiful petrified wood from the petrified forests of Arizona, near Adamana, is carried off in some quantity each year as specimens and souvenirs by tourists. The specimens taken are generally limited to a few pounds in weight, and some of them are later polished for ornamental purposes.

## PHENACITE.

A small quantity of phenacite was reported from Bald Face Mountain, Stoneham, Maine, by Messrs. Bickford Brothers, of Norway, Maine, and by Mr. Leon Allen. Part of this was gem material and part specimen material consisting of crystals attached to quartz crystals.

## QUARTZ.

The quartz produced, including rock crystal, smoky, citrine, rutilated, and tourmalinated quartz, came from California, Colorado, North Carolina, Maine, Pennsylvania, and Connecticut. In the first four States mentioned the quartz came from mines or regions around mines noted for their beautiful gems, as tourmaline, beryl, emerald, kunzite, and hiddenite. A small quantity of rutilated quartz was obtained from the mines near Hiddenite, Alexander County, N. C., and in the adjoining county of Iredell. Of much interest is the polishing of a large crystal sphere by the Catalina Novelty Company, of Avalon, Cal. This sphere is reported to be six inches in diameter and quite perfect.[a] According to a press report,[b] it is 19 inches in circumference and weighs 11 pounds. The crystal from which it was cut was found in Riverside County, Cal. The value of the sphere is placed at $3,300.

Mr. Louis J. Deacon mentions the occurrence of clear, pellucid quartz pebbles, called "Cape May diamonds," on the Delaware Bay beach at Cape May, N. J. These pebbles are gathered by visitors, who have them cut as souvenirs.

Consul-General G. E. Anderson, of Rio de Janeiro, states that the foreign demand for large-size quartz crystals for optical work is quite variable.[c] The value of the exports of such crystals from Brazil amounted to $16,103 in 1904, $18,132 in 1905, and $10,553 in 1906. The fluctuations are due in part to variations in supply. The best crystals come from a belt extending from the central portion of São Paulo through Goyay and the western portion of the State of Minas. The price given as the average for the exports during 1906 was 42 cents per kilogram.

## ROSE QUARTZ.

There was a large production of rose quartz, amounting to 51,300 pounds, from South Dakota and Colorado. The largest production was from South Dakota, from the Red Rose vein, 7 miles southeast of Custer. The whole output was not sold during 1907, however.

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[a] Personal letter. [b] Jewelers' Circ. Weekly, December 25, 1907. [c] Daily Cons. Repts., August 22, 1907.

Mr. Samuel Scott reports rose quartz in a number of localities in Custer and Pennington counties, S. Dak., though the deposits are not worked. Mr. J. D. Endicott reports the discovery of a ledge of unusually dark-colored transparent rose quartz 6 miles north of Texas Creek, Fremont County, Colo. The ledge is said to outcrop prominently on a mountain side for a length of 125 feet through a height of 30 feet. It occurs in the midst of pegmatite. This deposit is being operated by C. A. Beghtol & Co., and it is expected will yield much fine material. Mr. Frank H. Jackson, of Los Angeles, reports the occurrence of a vein of fine rose quartz in Hemet Valley, 20 miles southeast of Hemet, Riverside County, Cal. The vein is said to be from 6 inches to 3 feet thick, and the material could be obtained by the ton. Rose quartz occurs in numerous pegmatite bodies associated with the gem minerals of southern California.

## RUBY.

### NORTH CAROLINA.

Interest in the ruby deposits along Caler Fork of Cowee Valley, Macon County, N. C., has been revived through operations of the United States Ruby Mining Company. This company has undertaken to develop the ruby in the matrix lead previously located at "In Situ Hill" in the valley, and expects to wash the ruby-bearing gravels left unworked during former mining operations. For a distance of over 2 miles rubies have been found in the creek gravels, much of which has been worked. The gem-bearing gravels lie both above and below the company's headquarters at the mouth of Dalton Branch. Good rubies have been found in the creek gravels about a mile above the mouth of Dalton Branch as far as "In Situ Hill." This hill is merely the end of a ridge or spur which extends from the mountains on the south side of the valley down close to the creek.

In the report of Mr. C. Barrington Brown, in 1896, to the American Prospecting and Mining Company on the ruby mine of Cowee Valley, the rubies are described as generally of good color, many resembling the true pigeon-blood ruby of Burma. Some of them have bluish borders, which give them a magenta tint. Pratt and Lewis[a] state that some large gems—3 or 4 carats in weight—of good color and transparency and free from inclusions, have been found. Though found in less quantity, the color and quality of these stones equal the Burma rubies. Some of the Cowee Valley rubies contain inclusions of rutile, ilmenite, garnet, etc., or are silky or badly flawed. Much pink and red corundum, some of it approaching the ruby in color and quality, is associated with the ruby. The concentrates obtained in washing for ruby contain red, pink, bluish, gray, and yellowish corundum, ilmenite, rutile, cyanite, red and pink or rhodolite garnet, small zircon crystals, quartz, feldspar, etc. In the New York office of the United States Ruby Mining Company an admirable display of ruby and ruby corundum, as well as specimens of ruby matrix material, has been arranged by Mr. Alfred H. Smith.

During 1907, Mr. N. E. Isbell, of the United States Ruby Mining Company, constructed a new ditch to carry the creek from above "In Situ Hill" along the opposite hillside, where it could be tapped for pressure for hydraulic purposes. This ditch was extended to a point opposite the mouth of Dalton Branch, where a fall of nearly 100 feet could be obtained to hydraulic the bottom lands below. Another reason for the construction of the ditch was the hope that by turning the creek from its bed close to "In Situ Hill" the flow of water in the shaft on the ruby matrix would be diminished and the surrounding mud become harder. A 20-horsepower engine with a rotary centrifugal pump and bucket elevator were installed to assist in sinking the shaft and driving a crosscut from the bottom through the soft ground.

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[a] Pratt, J. H., and Lewis, V. L., Corundum and the peridotites of western North Carolina: Geol. Survey North Carolina, vol. 1, 1905, pp. 180-186.

The matrix in which the ruby corundum occurs, and in which genuine rubies are said to have been found, consists of hornblende gneiss and pegmatite in hornblende gneiss. The pegmatite occurs in small streaks and lens-shaped pockets from an inch or two to a foot thick, roughly conformable with the bedding of the inclosing hornblende gneiss. Both the pegmatite and the hornblende gneiss are very badly decomposed at the surface. The feldspar of the pegmatite has largely passed into kaolin, while the hornblende gneiss has altered to the yellowish brown earth characteristic of the saprolite of that rock, with hydromica and black spots where small garnets have rotted away throughout. That this weathering extends to a depth of over 30 feet is shown by the material removed from a shaft of that depth. The strike of the country rock at "In Situ Hill" is north of east, with a high dip to the southeast. A dike of hard unaltered hornblende eclogite outcrops in the bottom of the valley, a few feet north of the ruby matrix, and can be traced to the east and west some distance. The hornblende gneiss saprolite contains parallel streaks of mica-gneiss saprolite included in it.

In some of the pockets of decomposed pegmatite translucent pink to lilac colored corundum is very abundant, both in fairly large well-formed crystals and in small fragments. Red and ruby colored corundum is less plentiful, and but few crystals of gem quality have been found in the pegmatite bodies so far. Portions of the hornblende saprolite inclosing the pegmatite carry small translucent corundum crystals and fragments, some of rich red color in small pockets of soft white material. These were probably small masses of pegmatite which have decomposed, though they might possibly represent the decomposition products of former corundum crystals. From the few specimens of matrix seen by the writer, it appeared that the corundum associated with larger bodies of pegmatite is inclined to be of a lighter color—pink or lilac—than the richer red stones in the hornblende rock alone, or where pegmatite is less prominent.

## INDIA.

*Burma.*—The production of ruby, sapphire, and spinel by the Burma Ruby Mines Company during the year ended with February 28, 1907,[a] amounted to 326,855 carats, valued at £95,540, as compared with £88,340 in 1906. Of the total value of the output, ruby amounted to £93,023, sapphire to £1,132, and spinel to £1,385. The net profits of the company amounted to £15,160 after deducting a tax of £6,819 paid to the government of India.[b] During the year, 1,890,944 trucks of ruby earth were washed, at a cost of 7.7 pence per truck, as compared with 1,773,129 trucks at 8.1 pence in 1906.

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.

[b] Jewelers' Circ. Weekly, September 25, 1907.

## SAPPHIRE.

### MONTANA.

There was much activity in sapphire mining in Montana during 1907, with a consequent large production, both of the yogo-blue sapphires and of the varicolored sapphires found in other parts of the State. Two large companies operated mines containing blue sapphire in its original matrix, and two other large companies and smaller or individual producers worked auriferous placer deposits containing varicolored sapphires. The blue sapphire in matrix was worked in the Judith River region, in Fergus County, at points about 11 and 13 miles west-southwest of Utica, by the New Mine Sapphire Syndicate and the American Sapphire Company. Placer deposits of varicolored sapphires were operated on the head of Dry Cottonwood Creek, Deerlodge County, by the Variegated Sapphire Company, and along the West Fork of Rock Creek, in Granite County, by the American Gem Mining Syndicate. A little mining was done and a few finds reported from the auriferous sapphire deposits along the Missouri River, below Helena, once so extensively worked.

*Yogo blue sapphires.*—The blue sapphires of Fergus County, often called "Yogo sapphires," occur in a dike of basic igneous rock[a] cutting nearly perpendicularly across the bedded limestone country rock. The dike crosses the canyon of Yogo Creek (the north fork of Judith River) and the rolling country sloping eastward from the crest of Yogo Canyon to the bottom lands of Judith River, a distance of nearly 4 miles. The limestone country rock belongs to the Madison limestone formation of Carboniferous age, as mapped by W. H. Weed.[b] This formation is over 1,000 feet thick, and consists of thinly bedded strata of light-grayish limestone which dip rather gently to the east. There are a few minor folds in the limestone, some of which can be seen in the walls of Yogo Canyon near the mine of the American Sapphire Company. The sapphire-bearing dike is slightly sinuous and has a strike a little north of east with a nearly vertical dip. In the canyon, however, it seems to split up into two or more parts (one of which pinches out in the limestone) or to be intersected by another dike. The thickness of the main dike throughout its known length varies from 2 to over 14 feet.

The rock of the sapphire-bearing dike has been described by Prof. L. V. Pirsson. When fresh and unaltered it has a dark-gray color with a greenish or bluish cast. The principal constituents are biotite mica and pyroxene, of the diopside variety, with minute and large inclusions of calcite, quartz, pyroxene, and pyrite. Some of the biotite occurs in phenocrysts of 2 or 3 mm. diameter, though the greater part is in small shining flakes, thickly scattered through the rock. The glistening scales of biotite and some of the inclusions are the principal constituents that can be recognized in hand specimens. The inclusions of calcite and quartz are surrounded by reaction rims of pale and sometimes bright emerald green pyroxene. This pyroxene sometimes occurs scattered through the smaller inclusions, or even constitutes the mass of them. The dike rock contains numerous seams and veinlets of calcite and quartz as well as large inclusions of limestone. Pyrite in crystals and agglomerations of crystals is scattered through the rock. This pyrite, along with some pseudomorphous limonite, is separated from the rock along with the sapphires and constitutes the greater part of the concentrates obtained in washing for the latter. In thin section under the microscope the biotite is strongly pleochroic, varying from almost colorless to a strong clear brown color. It occurs abundantly in ragged shreds through the rock, rarely with crystal form, and contains small apatite crystals. The pyroxene is pale greenish to colorless and belongs to the variety diopside. It contains numerous inclusions which may originally have been glass. No feldspars have been observed in the rock, though a kaolin-like substance in the interstices may represent a decomposed mineral, as leucite or analcite, especially since the rock resembles a known basic analcite basalt.

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[a] Somewhat fully described by Weed and Pirsson: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3 1898-99, pp. 454-459 and 552-557.

[b] Geologic Atlas U. S., folio 56 [Little Belt Mountains], U. S. Geol. Survey, 1899.

The sapphires are scattered through the lamprophyre, none having been observed associated with the limestone inclusions. One sapphire crystal was seen embedded in a mass of heavily pyritized lamprophyre. It is thought the sapphires formed by the crystallization of an excess of alumina dissolved in the lamprophyre magma. The source of this alumina is supposed to be in the shales of the several thousand feet of older formations, underlying the thousand feet of Madison limestone through which the dike cuts. During the intrusion through the shales fragments were torn off and floated up with the magma, by which they were eventually dissolved. When the magma began to solidify the excess of alumina separated out in the form of sapphire. The sapphires crystallized out before the magma completely solidified, for some of them were badly etched and corroded by a partial reabsorption by the magma after formation. Included fragments of limestone taken in at higher levels were acted on to varying degrees by the magma. Smaller masses were metamorphosed to crystallized calcite, and nearly all were surrounded by diopside rims formed by the reaction on the magma.

The sapphires range in size from minute crystals up to 4 or 5 carats. Rarely crystals of 8 or 10 carats are found, the majority, however, weighing under 3 carats. A large quantity of small sapphire, classed as "culls," is obtained. This material is in great demand for watch jewels, for which, through the flattened form of many of the crystals, it is especially suitable. The color of the Yogo sapphire ranges from a light blue to the rich characteristic "cornflower" blue of the oriental sapphire. They make a beautiful gem and are highly prized for their color and brilliancy. Probably over 90 per cent of the sapphire is of good blue color and gem quality, the remainder being grayish or of poor color. Occasional purplish-colored gems are found. The Yogo sapphires occur in rough crystals whose common forms are the base and a rare rhombohedral face $x(30\bar{3}2)$.[a] The basal planes are roughly striated parallel to their intersection with the rhombohedron faces. A repeated development of the base and rhombohedron is not uncommon. The basal planes are badly etched on some crystals, the etched figures generally showing a rhombohedral symmetry and several being sometimes grown together.

*New Mine Sapphire Syndicate.*—The writer wishes to acknowledge the courtesy shown and the assistance rendered him by Mr. C. T.

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[a] Pratt, J H., Crystallography of the Montana sapphires: Am. Jour. Sci., 4th ser., vol. 4, 1897, pp. 24-428.

Gadsden, superintendent, at the time of his visit to the mine of the New Mine Sapphire Syndicate. The earlier mining operations of the New Mine Sapphire Syndicate consisted chiefly of open cuts, of which probably nearly a mile were made along the outcrop of the sapphire-bearing dike. These cuts were from 10 to 60 feet deep, in one place the dike material being removed to a depth of 90 feet. The walls of the cuts were held apart by stulls as needed. At present the sapphire ore is all obtained from underground workings. The latter consist of a shaft 100 feet deep with drifts in each direction from the bottom. The shaft is located in a smaller coulee or valley crossing the dike. The west drift is about 2,000 feet long and nearly 200 feet below the surface of the hill on the west of the coulee, while the levels above and one of the stopes reach nearly to the bottom of the 90-foot open cut in this hill. The east drift was carried nearly 800 feet, with stopes above at varying intervals. At one place in this drift the dike has been stoped out to the surface. The nature of the dike as exposed in these workings is variable in both richness and size. Nearly barren places occur in the dike where the latter seems to be choked with limestone, between the fragments of which there is but little dike material. The barren places commonly occur where the dike pinches down to smaller dimensions, which changes in size were doubtless caused by the jamming of limestone fragments included in the magma in the narrower parts of the fissure at the time of intrusion. In places the walls of the dike are rough where the edges of the limestone strata were broken during the fissuring and fragments were torn off by the intrusion of the dike. Jagged furrows or elbows in the limestone walls show where such fragments were torn off. In some places a single flat bedding plane of the limestone or steps, including several beds, form the bottom of these furrows, which are somewhat wedge-shaped toward the top.

Contrary to reports circulated during 1906 that the work of this company was hindered by the difficulty of disposing of the waste and slums from the sapphire washing, a larger supply of ore was mined and treated during 1907 than ever before. Instead of containing chemicals injurious to vegetation, as claimed by some of the ranchers along the river below the mine, the slums have been shown actually to improve, for raising crops, the lands on which they are turned. Analysis of the slum is also reported to show the presence of nitrates and phosphates, which are helpful to any crop growth. To test this, Mr. C. T. Gadsden, superintendent of the mine, turned the water carrying the slums over portions of the ranch land owned by the company. Oats, alfalfa, and vegetables were successfully grown, both where the slums were turned over crops already planted and where the vegetables were planted directly in thick deposits of slum. In each case vegetation was most luxuriant where the slum was thickest. The coarser sands from the sapphire washings were removed by a sand trap from the sluice ditches, where the grade was low, to keep the latter from clogging up. This was accomplished automatically by a simple device operated by an undershot water-wheel in the sluice.

In some respects the method of separating the sapphires from their matrix is similar to that of separating diamonds from the "blue earth" of South Africa. Near the surface and to a depth of 20 feet and more, the dike rock was decomposed by weathering to a yellowish clay, from which the sapphires were readily washed. As the work was carried deeper, the dike rock was less altered and hard, so that it has been found necessary to disintegrate it in some way before washing. This is accomplished by exposing piles of ore to the weather with occasional wettings. The action of moisture and air, aided by the frequent freezings and thawings of the winter climate, soon starts the slacking and disintegration of the lumps of "blue," as the ore is called. The disintegration is carried out on inclined floors or settling grounds, where the ore is deposited after removal from the mine. After an exposure of several months, a large stream of water is turned on the piles of "blue," which are forked over at the same time. The disintegrated surfaces of the lumps are washed off and down through a sluice along with other loose disintegrated material. This leaves the "blue" in apparently hard fresh lumps, which, however, soon begin to disintegrate and crumble again. The material in the sluice is carried over a set of riffles to a settling dam, where the lump material brought down undergoes further disintegration. From the first settling dam the "blue" is washed down over riffles to a second, for final disintegration.

The sluices are made of board and have iron-plate bottoms. Iron riffles are placed at the proper places in the sluice to catch the sapphires, and clean-ups are made four or more times in twenty-four hours. The concentrates are separated in a rocker sieve into three sizes, and each grade is panned down closer over a wooden tank. The oversize left on a screen of ⅜-inch mesh is carefully examined for large sapphires before discarding. The contents of the tank in which the panning is done receive further treatment on screens of two different meshes from those first used. Sapphires are picked up by hand from the coarse sizes of concentrates before shipping. The small sizes containing the culls for watch jewels are shipped in the rough. All the sapphires go to the company's office in London for cutting and marketing.

*American Sapphire Company.*—Through the courtesy of Messrs. John T. Morrow and C. H. Burr, consulting and attendant engineers for the American Sapphire Company, the writer was shown through the plant of that company and was assisted in the preparation of the following notes. The plant of the American Sapphire Company, operating on the same gem-bearing dike as the New Mine Sapphire Syndicate, is located in the canyon of Yogo Creek. The early work by former owners on this portion of the sapphire-bearing dike consisted of shafts and openings on the east side of the canyon. Some of these were near the edge of the bench land above, and others in the canyon walls. Prospects and shafts were also made across Yogo Canyon and along a tributary gulch to the west. Three different dikes are reported to have been located. One of these, in the bottom of the tributary canyon, was opened several years ago by a shaft about 100 feet deep, and good sapphire ore was found.

The mining of the dike rock by the present company is accomplished by drifts with stopes under the cliff on the east side of the canyon and a shaft at the mouth of the drift a little above the bottom of the canyon. This shaft was about 70 feet deep in September, 1907, and in pay ore. It was reported that the depth was about 100 feet early in 1908, and that the shaft was equipped with an electrical hoist capable of sinking to 1,000 feet. The level of the workings in the canyon is about 265 feet below the mouth of the old shaft on the cliff. The main drift has been carried to the east nearly 500 feet, with many hundred feet of levels and stopes above. The dike is somewhat irregular in shape and contains alternate rich and barren portions. The latter seem to be due, in places, to abundant inclusions of limestone, while in other places the dike pinches around projecting portions of the limestone walls. The outcrop of the dike in the foot of the canyon wall was not at first located, since it was rather indefinite and was partly covered with large blocks of talus. A crosscut tunnel was driven from the north side until the dike was located, and from this the main drift was carried eastward on the one side, and the dike traced to its outcrop in the canyon wall on the other. A large body of pay rock, apparently over 45 feet wide, was located by the crosscut and drift. Though the relation of this ore body to the dike was not definitely known at the time of the writer's visit, it seemed to cut across the regular dike with a dip of about 40° to the east. No definite hanging wall had been located, though the pay streak was about 12 feet thick from the foot wall. This body of ore had been brecciated and the broken masses squeezed into slickensided lenses.

The mine is equipped with a track running to the mill near by. The track is protected between these points by a shed, in order that severe weather may not interfere with operations. The ore is handled in steel dump cars of improved pattern.

The method of treating the sapphire ore is quite different from that used by the New Mine Sapphire Syndicate, the ore receiving special mill treatment soon after mining. It has been found that over 50 per cent of the ore removed by blasting is fine enough for milling without disintegration by weathering. The ore direct from the mine, after passing through 4-inch grizzlies, is digested with water in heavy revolving screens. The latter discharge three classes of material, the fines or slimes, which are immediately discarded, the oversize or material still in lumps, which is saved for further treatment, and the digested matter ready for sizing and concentration. The lump material is left in stock piles to weather for a period of several months, by which time it is readily digested in the revolving screens and concentrated. After sizing, the digested material is concentrated on Woodbury jigs arranged to treat three sizes, three-fourth and three-eighth inch and 6-mesh. Two jigs are run in series for safety. These jigs were handling about 75 tons in a day of seven and one-half hours at the time of the visit, though from 200 to 225 tons could be treated in twenty-four hours.

The concentrates from the jigs, in rare cases, run as high as 30 per cent sapphire, 5 to 10 per cent being more common. The concentrates containing the watch-jewel sizes, or culls, are treated on a Blake-Morscher electrostatic concentrator and their grade brought up to between 50 and 90 per cent sapphire. The final cleaning, as with the larger sizes suitable for cutting, is accomplished by hand picking. In filling hurry orders this cleaner is of value, since it enables a large quantity of sapphire to be selected much more quickly than could be done by hand alone. On the other hand, part of the sapphire goes over with the tailings, which require more labor to pick over than the original concentrates.

The operations of the American Sapphire Company have not yet reached the capacity of the plant, since much time has been consumed in perfecting the method of concentration in use and in exploratory work in the mine. The production of sapphires suitable for cutting amounted to over 100,000 carats between April and December of 1907. In addition, several thousand ounces of culls for watch jewels, bearings, and instruments of precision, were obtained at the same time.

*Variegated Sapphire Company.*—The auriferous placer sapphire deposits on Dry Cottonwood Creek, 16 miles N. 70° E. of Anaconda, were exploited with a dredge during 1907 by the Variegated Sapphire Company under the management of Mr. William Dodd. The deposits are located at an elevation of over 6,000 feet, nearly 1,500 feet above the valley of Deerlodge River, to which Dry Cottonwood Creek is tributary. The company owns some 2 miles of gulch land with beds of gravel 40 to 100 feet wide and from 10 to 14 feet thick. The gravels in some of the gulches to the side of the company's land and in the flats below are also reported as carrying sapphires.

The country rock in the region around the mine is a quartz porphyry, in places nearly a biotite granite. This porphyry is rather fine grained and composed of quartz and feldspar phenocrysts, with biotite laths and crystals in a ground mass. The quartz occurs in clear, glassy crystals and rounded grains, some of them fractured, thickly scattered through the rock. The feldspar, chiefly a plagioclase, has largely decomposed to kaolin in the surface rock examined. This kaolinization has taken place both within the crystals, on their exterior, and in the ground mass. The biotite also seems to have been partially hydrated, and in thin section under the microscope has a low birefringence and a strong dark-green to brownish-black pleochroism.

The source of the sapphires is not known. Mr. Dodd reports their occurrence farther up the gulch than the part examined, in a rock like the porphyry described above. The gravels in the gulch consist chiefly of blocks of porphyry, some of them rounded into cobbles, others flat and slab-like with but partially rounded corners. The overburden or top of the deposit, consisting chiefly of black muck with but little gravel through it, is 3 to 4 feet thick.

The dredge used by the company is of the bucket type, and has a capacity of 750 cubic yards in twenty-four hours. It is operated by a steam engine, and has a dynamo for its electric-light equipment. The material from the dredge buckets goes to a revolving screen from which everything over 1 inch in diameter is separated and turned into the pond under water at the back of the dredge, while everything under 1 inch in diameter is run over 56 feet of riffles. The débris from the sluice and the riffles is piled on the coarse material at the back of the dredge. In this way a dam is built which retains the water in the pond on which the dredge floats. By excavating before and constructing a dam behind, the dredge will be worked up the gulch. The grade of the gulch is not light, and the flow of the creek during the summer is quite small. The dredge cuts a square face in the gravels across the gulch. The overburden is first removed for a width of 6 feet upstream, being run directly through the dredge without washing. Mercury is placed in the riffles to catch gold, and clean-ups are made weekly. The sapphire concentrates are washed from the sluices of the dredge into a bin and are later sieved and panned down.

The gold recovered from concentrates is mostly fine, though nuggets worth several dollars have been reported. It is said the value of the gold obtained is sufficient to pay operating expenses. The larger part of the sapphire, either on account of small size or poor color, is suitable for mechanical purposes only, as watch and meter bearings. Some of the sapphires are suitable in size, quality, and color for cutting as gems. The predominant colors of the Dry Cottonwood sapphires are deep and light aquamarine and pale yellowish green. Other colors are clear and smoky blue, light and dark topaz yellow, straw yellow, yellowish green like olivene, light and dark pink; some stones are nearly ruby red, lilac and pale amethystine, and some are colorless. The pleochroism of some of the sapphires is marked, the same crystal appearing greenish when viewed across the prism and blue through its length, or pale and deeper pink, as the case might be. It is not unusual to find aquamarine-colored stones with a pink spot in the center. This combination furnishes an attractive gem when cut. A feature of the deep pink colored sapphires is their rich and beautiful color under artificial light, even when not very attractive in natural light.

The sapphires occur in rough crystals, often with curved faces, as irregular rounded masses, and as waterworn pebbles. The surfaces of those which are not waterworn are very much etched and corroded. One yellowish-green sapphire crystal, weighing a little over 4½ carats, had very much the shape of a rough diamond crystal. This effect is largely due to the fact that the development of the basal and rhombohedral faces produced a form resembling an octohedron. This apparent octohedral form along with marked curvature of the faces and peculiar etching produces the effect described. The proportion of waterworn sapphires is not large, and only a few show a large amount of wear. A few red and cinnamon-red garnets, mostly small, are found in the concentrates with the sapphires.

*American Gem Mining Syndicate.*—The operations of the American Gem Mining Syndicate for sapphires were confined to two gulches on the north side of the West Fork of Rock Creek, in Granite County, about 15 miles southwest of Philipsburg. These gulches are nearly a mile apart and are known as Anaconda Gulch on the west and Meyer Gulch on the east. Both drain to the south, Anaconda Gulch with a rather steep grade cutting through a small stretch of flat country along part of its course. Sapphires are said to have been found in the gulches and scattered over the surface of an area of about 2 square miles in this region.

The country rock around the sapphire deposits consists of coarse and fine grain porphyry, porphyritic tuff, conglomerate, quartzite, siliceous slate, and black limestone, the geological relations of which have not been worked out. In and near Anaconda Gulch the rocks underlying parts of the sapphire deposits are conglomerate, porphyritic tuff resembling conglomerate where the inclusions are plentiful, and porphyry. The bed rock in the lower part of Meyer Gulch is a dense, siliceous slaty rock of purplish color with a little black limestone. To the west of the sapphire-bearing deposits on the flats near Anaconda Gulch is rather coarse porphyry, probably granite porphyry, and to the north is fine porphyry. Ledges of tuff or conglomerate outcrop at one place on the flats where sapphires have been worked, and the gravels over part of the flats contain angular to subangular débris of porphyry, tuff, and conglomerate.

The porphyritic tuff is composed of feldspar and glassy quartz phenocrysts in a fine slate-gray matrix with inclusions of quartzite and other material. The inclusions observed range from an inch or two down in size, and the phenocrysts average about one-sixteenth of an inch across. The conglomerate at the sapphire deposits is composed of pebbles of quartz, red, brown, and gray sandstone and quartzite, gray and black chert, and a serpentine-like material, with a siliceous cement, the whole containing decomposed feldspar fragments throughout. The pebbles range in size from about 2 inches down. About a mile to the east of the mine is a bed of very coarse conglomerate forming cliffs 60 to 70 feet high along the north side of the West Fork. The pebbles of this conglomerate are composed of sandstone, quartzite, siliceous slate, and chert, with a compact, hard, red, jaspery matrix. These pebbles are well rounded and range in size up to 10 and 12 inches in diameter. While a number of them are very similar to those of the finer conglomerate at the sapphire mine, the frequent quartz pebbles of the latter seem to be lacking. There are pebbles and fragments of light-yellowish and greenish-gray to green serpentine-like mineral included in the coarse conglomerate to the east of and in the conglomerate and tuff at the sapphire mine. Large blocks of apparently the same material were found on the flats at the mine. The latter consisted of a fine-grained greenish-gray matrix with translucent dark-green blocks, resembling crystal fragments, included in it. Both the matrix and the inclusions were soft and like serpentine. In thin section the greenish inclusions were seen to be very fragmentary with a light, porous, kaolin-like looking material between the fragments. The latter were composed of many small, doubly refracting particles and fibers extinguishing at all angles.

The gravels in Anaconda Gulch vary from 30 to 100 feet in width and from a few inches to 8 or 10 feet in thickness. At the bends and in some of the hollows along the gulch gravel bars extend up the hillsides short distances. On portions of the flats along the gulch gravel beds occur, and good deposits of sapphire are reported to exist in channels leading to the gulch. At one place on the flats the gravels, and probably also the decayed tuff or conglomerate, have been washed for sapphires over an area of a number of feet square. The gravels in Meyer Gulch are from 30 to 40 feet wide in the lower part and from 100 to 200 feet wide farther up the gulch. In thickness they vary from a foot or two up to 8 or 10 feet, and are probably as much as 5 feet thick over a large portion of the area.

The gravels in both Anaconda and Meyer gulches are sluiced down with small hydraulics. The first part of the sluice is over bed rock and from this portion the bowlders and coarse débris are forked out. The finer material is then washed down through board sluices over cross riffles. The latter are removed and cleaned up each day. In Meyer Gulch the tailings from the riffles are carried through several hundred yards of wooden sluice to remove the waste from the gulch near the workings. This sluice has riffles with bars parallel to its length, largely to protect the boards of which it is constructed, though partly to catch sapphires that have washed over the cross riffles. The parallel riffles are cleaned up at wide intervals of time. All of the concentrates are further cleaned on a jig operated by a small water wheel. The concentrates from the jig are oven-dried and shipped for picking. Gold is also saved from the concentrates. The tailings from the jigs contain rutile in elongated, much water-worn pebbles, scaly hematite in quartz, garnet, corundum, pyrite, manganese ore, siliceous iron pebbles, and other minerals.

The sapphires from the Rock Creek region are principally used for mechanical purposes, though some are of good color and quality and of sufficient size to be cut as gem stones. The prevailing color is some shade of green, as the yellowish and bluish green of beryl and aquamarine. Blue, yellow, purple, pink, and red sapphires are found, however. The greater part of the sapphires are shipped to Switzerland, where they are cut for use as watch jewels and for other bearings.

### COLORADO.

Mr. C. A. Beghtol reports the discovery of sapphire in the matrix in Fremont County, Colo., by a prospector named Weston. The latter would not reveal the locality.

### INDIA.

*Kashmir.*—The production of sapphire during 1906 from the Kashmir mines[a] amounted to 2,837 carats, valued at £1,327.

*Burma.*—In the operations of the Burma Ruby Mines Company during the year closing with February 28, 1907, sapphire valued at £1,132 was produced.[a] The quantity of sapphire produced is not given separately, but is combined with that of spinel and ruby, the total of which amounted to 326,855 carats.

### CEYLON.

A blue sapphire weighing 466 carats after cutting and polishing is reported to have been found in Ceylon during 1907.[b] If the report is true, this is the largest blue sapphire on record, and if the stone is of good color and free from flaws it should be worth several thousand dollars.

### AUSTRALIA.

*Queensland.*—The value of the sapphire production of the Anakie field during 1907 is given at about £40,100,[c] as compared with £18,000 in 1906. The miners sell their sapphires to resident dealers,[d] who in turn ship them to merchants in Europe. Probably 75 per cent of the stones go to Germany. The average price per ounce paid for sapphires during the last five years has been approximately as follows: 1903 and 1904, 15 shillings; 1905, 15 shillings to £1; 1906 and 1907, £1 4s. The sapphires are graded into three classes—first-class blue, second-class blue, and "machine stones," named in order of their value. The use made of the "machine stones" is not definitely known, though it is supposed they are applied in mechanical apparatus.

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.

[b] Manuf. Jeweler, November 7, 1907; from London Standard.

[c] Mining Jour., London, March 14, 1908.

[d] Mining Jour., London, February 22, 1908.

## SMITHSONITE.

Translucent, apple-green smithsonite, not only furnishing beautiful cabinet specimens but cutting pretty gems, has been found in large masses in the Magdalena mining district, New Mexicco. This smithsonite occurs in the Kelly mine, which is being developed by the Tri-Bullion Smelting and Development Company. It was found in a zinc vein in a cavity or vug several feet wide and 25 feet long, which it lined and partly filled with odd-shaped masses. The surface of the smithsonite masses has a mammillary structure which is drusy with the edges of many small projecting crystals. The mineral assumes odd shapes and sometimes nearly a globular form. One specimen, seen in the New York office of the Tri-Bullion Company, was roughly about the size and shape of the head and bust of a man. It had a beautiful light-green color and was covered with drusy mammillary lumps an inch or two across.

This green smithsonite occurs in shells or layers, up to an inch or two in thickness, coating rough, irregular masses of typical dry bone or carbonate zinc ore. The shells of smithsonite have a columnar structure across them, with a slight radial arrangement of the columns. Ordinary smithsonite or zinc carbonate is colorless or white. This material contains variable quantities of a copper salt, which give it a beautiful green color. The copper stain is not evenly distributed through the mineral, but occurs in layers parallel with its surfaces. This smithsonite is being cut and sold as a gem in some of the Western States. It yields handsome cabochon stones similar to chrysoprase, though of course not so hard and therefore less valuable than that mineral. Mr. Hart, of Manitou, Colo., reports that the rough mineral for gem purposes brought from $2 to $5 per pound at Magdalena.

## SPHALERITE.

Dr. George E. Ladd reports that sphalerite crystals from the zinc-lead mines of Missouri are used locally in jewelry without cutting. The clear, rich, resin-colored crystals make handsome stick pins. The mineral is too soft, however, for extensive use.

## SPODUMENE.

### KUNZITE AND HIDDENITE.

*United States.*—There was a large production of lilac-colored spodumene or kunzite in the southern California gem region during 1907. The output of gem spodumene amounted to about 125 pounds of selected material, part of which was pale green, colorless, and yellowish. The production came from the Pala Chief and the Caterina mines, near Pala, and the Mack mine, near Rincon, all in San Diego County.

The development for the emerald-green spodumene or hiddenite deposit in North Carolina was described under "Beryl." Further work on the lilac and pale-green spodumene deposit at Andover, Oxford County, Me., has yielded mineral of good color, though clear only in small patches. Mr. F. G. Hillman reported surprisingly beautiful gems cut from material that had been pronounced valueless by two dealers in precious stones.

*Madagascar.*—Mr. Albert Dabren, mining engineer of Madagascar, reports the discovery of gem kunzite and hiddenite on that island. In a personal letter to the writer, dated Tananarivo, May 1, 1908, Mr. Dabren states that the material is comparable with that of California and North Carolina in beauty.

## TOPAZ.

### UNITED STATES.

Topaz was produced in Utah, California, Texas, Maine, and New Hampshire during 1907. Prof. F. W. Clarke mentions an occurrence of topaz on Baldface Mountain, near North Chatham, N. H., where faintly bluish and colorless crystals, suitable both for specimen and cutting, are found. This locality is only a few miles from the Stoneham, Me., topaz locality.

*Texas.*—The production of topaz in Texas came from a new locality, near Streeter, Mason County, and was reported by Mr. R. L. Parker to amount to about 20 pounds. Part of this topaz was found as pebbles in the drift of a small branch and part in place in pockets embedded in yellowish clay, associated with crystals of smoky quartz, tabular feldspar, and mica. Mr. Parker describes the topaz as varying from colorless to white, bluish, greenish, and amber in color. Of three specimens sent to the Survey, one is a cleavage fragment of a waterworn crystal, colorless, and perfectly clear; another crystal is perfectly clear with a slight bluish tint; and the third, a large crystal weighing about 4½ ounces, is clear in portions, with a delicate bluish-green tint. It is probable that very beautiful material will be obtained from this locality.

Though well supplied with faces, the two crystals available for examination apparently presented no new forms. The forms determined with reasonable certainty by hand measurements were the prisms m(110), l(120), and g(130), brachy-pinacoid b(010), macrodome h(203), brachydomes f(021) and y(041), and pyramids u(111), v(121), o(221), and i(223). The character of the crystal faces varies considerably on the two crystals. Some are polished; others are clouded, etched, and striated.

*California.*—The production of topaz from California came from the gem mines 4 miles N. 75° E. of Ramona, San Diego County, and principally from the Little Three mine at this locality. These mines produce, besides topaz, hyacinth-colored garnet, tourmaline, quartz, and albite or clevelandite. Some of these stones yield rich gems, while others form beautiful cabinet specimens. The mines from which they are obtained are described under "Gem minerals of southern California."

## TOURMALINE.

### UNITED STATES.

The production of tourmaline amounted to about 2,140 pounds of rough gem crystals. California contributed the bulk of the production, and Colorado, Maine, and Connecticut made up the remainder. The greater part came from the mines of the Himalaya Mining Company, the Mesa Grande Gold and Gem Mining Company at Mesa Grande, San Diego County, and the Pala Chief mine at Pala. The mines of the Royal Gorge region, Colorado, operated by C. A. Beghtol & Co., were the next largest producers. Mr. J. D. Endicott reports the discovery of a new tourmaline deposit in pegmatite inclosed in garnetiferous mica schist in Fremont County, Colo. A new deposit of tourmaline was reported from the Pala region, San Diego County, Cal., by Mr. John W. Reed, late in 1907. A pocket opened in this deposit contained over 150 crystals, some 2 or 3 inches in diameter and several inches long, which had a lavender color. Several tourmaline mines in California are described under the "Gem minerals of southern California."

### INDIA.

The production of tourmaline from the Ruby Mines District of Burma during 1906 amounted to 193 pounds, valued at £1,001, as compared with 161 pounds, valued at £1,500 in 1905.[a] Mr. E. C. S. George, deputy commissioner of the Ruby Mines District, describes the workings for tourmaline [a] about a mile east of Maingnin. These deposits were worked by the Chinese about 150 to 200 years ago. According to local tradition they were again opened temporarily by Kachins about forty years ago. About 1885 the deposits were reopened and more systematically worked until 1895 under Pir Seinde. Since 1899 they have been worked by licenses, and during the last three years this locality has produced about £200 worth of tourmaline annually.

The tourmaline occurs in soft, decomposed, granitic veins, generally covered by a thick layer of jungle soil. Isolated crystals are sometimes found in the yellowish earth associated with the granite or the red soil capping it. The discovery of the deposits made from shafts 4 or 5 feet square with underground workings is almost entirely accidental. Some of the shafts are about 100 feet deep, which seems to be the limit of the native skill. The tourmaline is sorted into three classes: (1) Best pink rubellite; (2) darker colored crystals, lower part brown or black; (3) fragmentary crystals of any color, or imperfect small crystals. The best varieties bring from £80 to £100 per viss (3.65 pounds).

### TURQUOISE.

There was a production of nearly 600 pounds of rough selected turquoise and of nearly 3,000 pounds of turquoise matrix during 1907, from Arizona, Nevada, Colorado, New Mexico, and California. The greater part of the production came from the mines near Mineral Park, Ariz. The output from Colorado came from the mines near La Jara, Conejos County, operated by the Colorado Turquoise Mining Company. This company reported development work by two tunnels 200 feet and 100 feet long, respectively, and four shafts 105 feet, 97 feet, 70 feet, and 50 feet deep, respectively. Mr. E. H. Davis, of Mesa Grande, Cal., mentions the discovery in December, 1907, of a turquoise deposit in the Colorado desert on Carrizo Creek. Turquoise seams in a dark matrix are especially suitable for cameo coverings, and some of the native material has been used with excellent results for this purpose by Messrs. F. J. Essig, of Chicago, and William Petry, of Los Angeles. This turquoise cameo stone comes from Esmeralda County, Nev., and consists of good blue turquoise in seams an eighth of an inch or more in thickness in a dark gray chalcedony matrix. The latter furnishes a good background for the turquoise carving.

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907, p. 83

## NEW MEXICO.

Turquoise is known to occur at several places in the Burro Mountains of Grant County, N. Mex. A description of one of these deposits—that of the Azure Mining Company, about 15 miles southwest of Silver City—with notes on the geology of the surrounding region, has been given by Mr. Edward R. Zalinsky.[a] The Azure mine, the American Gem and Turquoise Company mine, one-half mile southeast, and the Porterfield Turquoise Company mine, one-half mile south of the Azure mine, were briefly visited by the writer during the fall of 1907. The following description has been prepared from Mr. Zalinsky's article and the writer's notes:

During the last part of 1907 a small amount of work was done on the Azure mine, opening up the lower levels and preparing to push developments during 1908. The mine had not been operated since 1905. The American Gem and Turquoise Company mines also have been idle for the last few years. The Porterfield turquoise mine was not worked during 1907, though there was a large production from small excavations in 1906.

The country rock of the turquoise region is granite which presents various phases in texture, composition, and degree of alteration. The greater part of the granite has a porphyritic texture, which varies from coarse to very fine. Much of this granite has undergone such extensive kaolinization that it is often difficult to determine the constituent feldspathic minerals. The texture varies considerably and in some places is finer grained and more porphyritic than in others. A common variety of the granite has coarse pink feldspar phenocrysts. A thin section cut from a specimen of this granite collected at the Copper King mine, about one-third mile southwest of the head of the Azure mine, contained orthoclase, a plagioclase, quartz, biotite altering to chlorite, magnetite, and zircon. Another section cut from a specimen from near the east wall of the Azure vein contained orthoclase, a little plagioclase, probably albite, and quartz in grains and veinlets. The feldspars were partially kaolinized and the kaolin much stained with limonite. Another form of occurrence is a spotted porphyritic granite with phenocrysts of orthoclase and plagioclase 2 or 3 millimeters square. A thin section from this variety of rock at the Porterfield mine contained orthoclase and plagioclase in phenocrysts and biotite shreds scattered through a groundmass of feldspar and quartz. All of the feldspars were partially kaolinized.

Mr. Zalinsky describes the occurrence of mica-andesite porphyry stocks and andesite dikes of pre-Tertiary and Tertiary age. It was probably during the intrusion of these bodies that the rock of the region was fractured and mineralized. The turquoise deposits adjoin the copper deposits of the Burro Mountains on the northwest, and copper staining is present throughout their extent.

*Azure turquoise mine.*—The Azure mine has been worked on an immense scale by an open cut that is about 60 feet deep in its deepest portion, from 70 to 100 feet wide, and about 200 yards long, with adits on two levels below the open work. The vein is in a badly fractured zone and strikes about northeast with a dip of 45° to the southeast; it is about 40 feet wide, though locally over 60 feet wide. The joints produced during fracturing dip both parallel to the vein and across it to the northwest. Slickensides and evidence of movement are more pronounced on the fissures parallel to the vein, and two such prominent fractures form the walls of the vein through part of its extent at least. The country rock is porphyritic granite, badly altered through kaolinization, portions of which form the mass of the vein. A large amount of silicification has hardened the rock in many places so that it does not resemble ordinary decomposed granite. This silicification is represented by the deposition of quartz in part throughout the rock and in part in seams and veinlets cutting it at all angles.

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[a] Economic Geology, July-August, 1907, pp. 464-492.

Turquoise occurs as veins and veinlets filling the joints and fissures in the rock and as nuggets. In places these veinlets are mere films, and in others they are as much as three-fourths of an inch thick. Part of the turquoise is found in groups of small rounded masses resembling nuggets, fitted roughly together though separated from one another by kaolin or clay and enveloped in it. These groups of nuggets generally fill a flattened lenticular-shaped pocket in one of the veinlets. The best turquoise came from a portion of the vein known as the "Elizabeth pocket," which extends from the second level to the surface, a height of 40 to 60 feet, and may include a width of 40 feet and a length along the vein of 150 feet. The vein rock near this pocket is cut by an unusually large number of quartz seams and veinlets up to a half inch wide. These contain crystal-lined cavities in places, and veins of turquoise sometimes contain quartz crystals penetrating them. The quartz veinlets sometimes give place to turquoise veinlets or include patches of turquoise. Where portions of the rock are less altered and pink feldspars occur, turquoise of a bright blue color is found. Turquoise veinlets of different shades of color are found crossing each other, indicating different periods of deposition and different sources of material.

Good turquoise was found at other places in the vein than in the Elizabeth pocket. To the northeast of this pocket much of the turquoise had a greenish cast, while still farther along good blue variety was more plentiful. To the northeast of the open cut the Azure mine did not yield much turquoise of good color in a drift several hundred feet long. To the southwest of the open cut the vein is readily traced for several hundred yards up Morrills Canyon. It contains very little turquoise, however, but has been proved to carry fairly rich copper ores. Mr. William R. Wade, who has directed the openings on this vein for copper, reports that a little turquoise was found in the Copper King mine at a depth of 410 feet. In the workings at the Azure mine the best turquoise was found at depths of less than 100 feet. Pyrite or sulphides were not observed associated with the turquoise, though the wall rocks are colored red with hematite in places. Where the feldspars of the rock have been the most extensively kaolinized turquoise is found mostly in nugget form. In less altered rock hard vein turquoise is found, and both varieties are found in moderately altered rock.

Mr. Zalinsky mentions the various colors found in turquoise at the Azure mine and the associations with other minerals and matrix. Nearly all shades of blue and green occur—dark blue, sky blue, light blue, bluish green, light green, and dark green—and in some cases reddish-brown, chocolate, and violet-colored material has practically the same composition as turquoise. A combination of colors in the same piece is not uncommon, especially in mottled matrix, as bright blue spots or lines in paler turquoise. The mineral halloysite is associated with turquoise in olive-green and grayish masses and in nugget form similar to turquoise nuggets. Halloysite is opaque to translucent and has a waxy luster. When moist and fresh from the mine the halloysite has about the consistency of candle wax. It hardens and cracks on exposure to the air, however, though it does not become so hard as turquoise. Among numerous associations the following were noted: Pale-blue vein turquoise with a network of yellowish-brown hydrous aluminum phosphate streaks; blue-white vein turquoise containing open cracks and streaks of darker material; light-blue vein turquoise containing yellow spots of phosphate, quartz grains, and darker veinlets of purple and blue parallel to the walls.

The turquoise from the Elizabeth pocket is probably the finest ever found in the world. Much of it is of a deep blue color, slightly translucent, and over 6 in hardness, so that it makes a fine wearing gem. The cut gems of good quality from the Azure mine are marked with a circle on the lower side, and such stones are guaranteed to hold their color for a number of years or to be replaced. Mr. Zalinsky states that the Azure mine has produced turquoise to the value of several million dollars since 1891.

Mr. Zalinsky suggests that the turquoise was formed in the vein where copper-bearing solutions, rising in fissures with a northwest dip, crossed phosphate-bearing solutions rising in fissures parallel to the vein with a southeast dip. In support of this theory the occurrence of such copper minerals as malachite and chrysocolla in the copper fissures above the supposed phosphate fissures is cited. It is thought the phosphoric acid of the turquoise was derived from the decomposition of apatite in the original granite and the alumina from the decomposition of the feldspar of the same rock. Where copper was supplied in excess, the turquoise runs toward green in color. The proper proportion of copper gives the best bright blue gem of greater hardness than where the copper was not present in sufficient quantity. In the latter case the turquoise is of pale color and inferior hardness, and apparently this variety grades into simple phosphate of aluminum.

*American Gem and Turquoise Company mines.*—The operations of the American Gem and Turquoise Company were upon the deposits in the Parker mine and near the prehistoric workings about 200 yards to the northwest. At the latter place the recent work consists of two tunnels, of about 50 and 60 feet in length, driven in from a small open work at the outcrop on a hillside. One of these tunnels running southwest followed prominent seams, which carry turquoise in places and dip about 50° to the southeast. The other tunnel cut across the direction of the prominent seams and appeared to be exploratory work. The country rock is typical quartz porphyry with prominent glassy quartz phenocrysts and badly kaolinized feldspar crystals.

Mining at the Parker mine was accomplished principally by open cuts, of which two are fairly large. The one to the north was made in a gully running east, and is nearly 100 yards long and 10 to 25 feet deep. The country rock is hard quartz porphyry like that near the prehistoric workings. A number of seams carrying turquoise cross the open cut in a northeast direction with southeast dips. Other seams, and one especially prominent seen in the end of the cut, run nearly east and west with a high northerly to vertical dip. Turquoise occurs in films, seams, nuggets, and irregular masses in the matrix. The prominent seam mentioned was from 2 to 6 inches thick, and carried pale turquoise and matrix in masses of nearly equal thickness. Much of the turquoise in this seam is too soft and of too poor color to be of great value; part, however, would yield good matrix gems.

The openings farthest south consist of irregularly shaped open work with a small amount of tunneling. The main cut is nearly 50 feet deep on one side and probably 100 feet across. This cut is situated on the contact of the typical quartz porphyry on the northeast and the altered country granite on the southwest. The rock is jointed in different directions, some of the seams running northeasterly. The turquoise occurs in films and veinlets in many of the joints, and some of a fine bright blue color nearly a quarter of an inch thick was seen in the open cut.

Part of the turquoise from these mines is of the same high grade as much of that from the Burro Mountains. The guaranteed cut gems of this company are marked with a cross (x) on the lower side.

*Porterfield Turquoise mine.*—The Porterfield Turquoise mine is on the west side of St. Louis Canyon, on each side of the mouth of a small gully. The work at this mine has not been extensive and consists of several tunnels and shafts with small open cuts and prospect pits. Two of the deeper shafts are between 40 and 50 feet deep, and the longest tunnel is nearly 170 feet in length. Turquoise of the best quality was found most plentifully during 1906 in irregular open work near the bottom of the gully.

The country rock at the mine consists of different types of granite porphyry. A prominent type has large crystals or phenocrysts of red orthoclase through a quartz and biotite matrix, and approaches a granite in texture. Another type is a finer spotted porphyry, composed of orthoclase with some plagioclase and quartz phenocrysts in a groundmass of feldspar and quartz. Biotite is locally present in quantity in small six-sided crystals generally badly altered to chlorite. Another type is a quartz-feldspar granite, somewhat porphyritic, in which biotite and similar minerals are lacking. In the majority of these rocks the feldspars have been partially kaolinized, while abundant silicification has taken place. The latter is represented by much secondary quartz binding the particles of rock more closely together and in seams cutting the rock in various directions.

Turquoise has been found in prospects in a belt about 100 yards wide and over 200 yards long in a direction east of north and west of south. This area is marked by numerous joints, of which many prominent ones strike northeast, though others cut across this direction at various angles. The turquoise occurs in seams, veinlets, lenses, and groups of nodules or nuggets in lens-shaped masses. Among the minerals associated with turquoise the most common is a white, koalin-like clay which coats the nuggets and in places forms an important part of the filling of seams. Among other minerals observed associated with turquoise and in turquoise-bearing seams were hematite, quartz, limonite, hyalite opal, chalcedony, and greenish, waxy halloysite, which in places assumes the form of nuggets like turquoise. The turquoise occurs in seams running in various directions, the larger veinlets often having stringers extending out in seams crossing them. The joints and seams in the vicinity of turquoise-bearing ground often show indications of turquoise in the form of blue, bluish-green, green, yellowish-green, and whitish coatings or stains.

Choice lots of turquoise that range from deep robin's-egg blue to blue of pale shades and that would yield one color gems of 10 to 20 carats (or even of 30 carats) are reported to have been obtained from this mine. The largest yield of turquoise of one color is in stones of 1 to 10 carats, while considerable matrix material and mottled turquoise are reported to have been found. Mottled turquoise presents a number of variations of light-blue turquoise speckled with dots of deeper blue. In one specimen seen the dark blue mottling consisted of small dendritic masses resembling the markings in moss agate. Judge M. M. Porterfield, owner of the mine, states that the deep-blue stones of finest quality when cut bring from $1 to $10 per carat for those under 10 carats in weight and $10 or more per carat for those weighing over 10 carats. The matrix stones bring from 25 cents to $1 per carat, and the mottled turquoise brings a little more than the matrix. The Porterfield turquoise when cut is marked with a cross (x) on the lower side, as are those of the American Gem and Turquoise Company. With better facilities for marketing, the production of the Porterfield mine could probably be considerably increased.

## UTAHLITE AND AMATRICE OR VARISCITE MATRIX.

Amatrice is the new name given to utahlite or variscite with its associated matrix, as now mined and cut by the Occidental Gem Corporation of Salt Lake City. The word "amatrice" is a combination of the first letter of the word American and of the word matrice, and is intended to indicate that the gem is a matrix stone of distinctly American origin. During 1907 the Occidental Gem Corporation worked the deposit of utahlite in the Stansbury Mountains, Tooele County, Utah, described by Dr. George F. Kunz in this report for 1905. The company reports about 100 feet of tunnel opened and 30 feet of cuts made. The gem occurs in nodular form with a coating of chalcedony and other minerals. The production of finished gems from the rough material mined amounted to about 20,000 carats.

Amatrice is composed of variscite, wardite, and probably other allied minerals, chalcedony, and quartz. Variscite and wardite occur together and both are hydrous phosphates of aluminum with colors ranging from deep grass green to paler shades of green and slightly bluish green. Both minerals are compact and tough, the hardness varying from a little over 4 in variscite to about 5 in wardite. The matrix consists of chalcedony and quartz with other minerals, among which are yellowish gray and white phosphates, probably in part variscite or allied minerals, sometimes deposited around portions of green variscite or banded with chalcedony. In both the variscite or wardite and the adjoining matrix there is an oolitic texture with the shot-like masses recemented together with mineral of a different shade of color. Much of the chaledony is dull and chert-like, with the color varying from dark red and yellow brown to buff and gray.

The charm of amatrice is due to the wide range of colors of the several minerals composing it and the numerous combinations these colors make with one another. These combinations of color are due to several causes, among which are the deposition of the different minerals or colors in agate-like bands either around a fragment of other mineral as a core or filling cavities however formed, and the brecciation of both the variscite and matrix with subsequent deposition of other minerals or of the same mineral with different shades of color in the cracks and seams. Among the odd combinations of color may be mentioned light-green with deep-green "cobweb" or "turtle-back" mottling, with or without other colored matrix; dark brown or yellow matrix in seams and irregular masses with light or dark green background, or vice versa; yellow, gray, and white matrix inclosing or inclosed in green of varying shades.

Mr. Don Maguire reports a considerable production of utahlite, or chlor-utahlite, from the Camp Floyd mining district, Utah County, about 2 miles south of Mercur gold mine. This locality has been described by Dr. George F. Kunz in his reports on the production of precious stones for 1894 and 1904.

## GEM MINERALS OF SOUTHERN CALIFORNIA.

Mining for precious stones in San Diego County was actively pushed during the first part of 1907, and a considerable output was obtained. During the last half of the year operations were but intermittent or suspended at a number of the mines. The principal production of gems came from around Mesa Grande and Pala, though there was a smaller production from Rincon, Ramona, Riverside, Oak Grove, etc. At Pala varying amounts of work were done at the Pala Chief and Tourmaline Queen mines, owned by the Pala Chief Gem Mining Company; at the Stewart Lithia mine, or its extension, owned by the American Lithia Company; at the Caterina, Hiriart, and Naylor-Vanderburg mines on Hiriart Mountain, owned by the Sickler Gem Mining Company; and on claims on the north side of Hiriart Mountain. At Rincon there was an output of tourmaline and kunzite from the Mack mine. At Mesa Grande work was done at the mines of the Himalaya Mining Company, the Mesa Grande Consolidated Gold and Gem Mining Company, the San Diego Gem Mining Company, the Native Gem Mining Company, the J. M. Cota mine, the Trail mine, and the Rose Quartz mine. At the mines on the hill 4 miles N. about 70° E. of Ramona the Little Three, Hercules, Lookout, Reliance, and Mars claims and the Daggett mine were tested or worked.

### PALA.

*Stewart Lithia mine.*—The Stewart Lithia mine is located about a mile and a half northeast of Pala on the end and along the east side of a ridge or spur of a mountain. The vein consists of a pegmatite mass nearly 50 feet thick in places and outcropping prominently for a third of a mile or more; part of the outcrop to the north belongs to the Messrs. Labaugh. It has a northerly strike with a gentle dip (10° to 15°) to the west. The principal work has been to the south for lithia minerals at the point of the spur where the pegmatite ledge outcrop extends from the east side to the west side. Tunnels have been cut through the ridge exposing large masses of lepidolite and amblygonite. Compact lepidolite can be obtained here by the hundred tons. Later work at the Stewart mine consists of several cuts and tunnels to the north of the main workings and at different points along the ledge. In some of these openings the lepidolite was more coarsely crystallized though less plentiful than in those to the south, and both gem tourmaline and kunzite were found. Tourmaline occurs in coarse pink crystals in portions of the vein. In places these crystals have badly altered to a soft substance resembling pink talc or kaolin in feeling and consistency. This is doubtless the halloysite clay described by G. A. Waring[a] in his paper on the pegmatite veins of Pala, San Diego County. The occurrence of lepidolite in the pegmatite is quite irregular. In places the ledge has ordinary pegmatite at the top, called "capping," and containing much black tourmaline in crystals through it. The lithia and gem minerals occur in large pockets or masses scattered irregularly through the pegmatite. Defunct and unaltered tourmaline and kunzite occur associated with or near masses of lepidolite. In these places the feldspar and other minerals occur in large crystals or masses, and graphic pegmatite is common. Crystals of feldspar 6 and 8 feet long were seen in one of the gem-bearing portions. The lower portion of the pegmatite is thought to be barren and is finer grained than the upper.

*Tourmaline Queen mine.*—The Tourmaline Queen mine lies near the top on the east side of the same mountain as the Stewart mine, and about one-half mile northwest of it. Beautiful pink tourmaline, green in some portions, has been obtained at this mine, along with the feldspars, lepidolite, black tourmaline, garnets, etc. The main ledge at this mine is 10 to 15 feet thick, though at the place opened it appeared to be only a foot or two thick. The principal work consists of two open cuts of but moderate size.

*Pala Chief mine.*—The Pala Chief mine is nearly 1 mile east of the Stewart mine, near the top of a knob on the opposite side of a valley. The pegmatite ledge at this mine is from 15 to 20 feet thick, apparently lying on and about parallel with the surface of the hill. It has been worked by an open cut about 100 yards long and from 6 to 25 feet deep in a direction north of west and south of east. The pegmatite contains considerable black tourmaline and graphic granite through it. The gem-bearing portions or pockets contain lepidolite. Both kunzite and tourmaline are found in some of the pockets, though the openings at the western end of the cut have yielded more tourmaline than kunzite. A large part of the kunzite of southern California has been obtained from this mine.

*Caterina mine.*—The Caterina mine is located at the foot and on the south side of Hiriart Mountain, about 2½ miles north of east of Pala. There is a large pegmatite ledge at this mine striking in a northerly direction with a dip of about 30° W. The lower part of the ledge consists of a fine-banded quartz-garnet rock. The principal work consists of an open cut with an incline and drift from it. A large gem-bearing pocket, 6 or 8 feet thick and followed down about 30 feet on the incline, has been opened. At one place near the bottom the pocket was pinched down by a mass of crystal quartz to a thickness of 4 feet, but opened out below it. The pocket contains much crystal quartz, pink clay, and partly decomposed spodumene crystals. The spodumene crystals were of large size, and have decomposed to whitish and pinkish clay of tallow-like consistency, or have only partly decomposed and still contain kunzite of good color. Some of the spodumene crystals were 6 to 12 inches thick and a yard or more long. Part of the tourmaline in the pegmatite at the Caterina mine has a deep indicolite blue to nearly black color.

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[a] American Geologist, June, 1905.

*Vanderburg mine.*—The Vanderburg claim lies on the east side and near the top of Hiriart Mountain, and is probably on the same ledge as the Caterina. In the open cut on the outcrop it is said a perfect kunzite crystal weighing 1½ pounds was found. A crosscut tunnel has been run in for a distance of 150 feet, 35 feet below the outcrop, and good kunzite was found where the ledge was cut. The latter appears to strike north with a westerly dip and is possibly 35 feet thick.

*Hiriart mine.*—The Hiriart mine is but a few hundred yards east of the Caterina mine. The work consists of an open cut with a drift about 75 feet long. The pegmatite ledge is from 2 to 4 feet thick and strikes N. 15° E. with a dip 30° W. The crystallization of the minerals was in part perpendicular to the walls of the "vein." The gem minerals are blue and green with some pink tourmaline, associated with lepidolite, quartz, and albite crystals.

## RINCON.

*Victcr beryl mine.*—The Victor beryl mine is in a ravine just east of the little village in the Rincon Indian Reservation. The pegmatite is about 6 feet thick and strikes west of north with a dip of 45° W. The crystallization of the pegmatite in the interior of the vein is quite coarse, and there are many small pockets. These pockets contain smoky quartz and beryl, of which part is handsome aquamarine. The vein has been worked by stripping and removing for a distance of about 50 feet and to a depth of 15 feet.

*Mack mine.*—The Mack mine is on a hillside about a quarter of a mile south of the Victor mine. The pegmatite ledge at this mine is about 12 feet thick, strikes west of north, and dips about 50° E. There are pockets through the whole vein, carrying lepidolite, albite, quartz, tourmaline, garnet, kunzite, etc. There is a gem-bearing streak in the interior which is richer than the remaining portion of the vein. The mine has been worked by stripping off the hanging wall and by open work.

## MESA GRANDE.

*Himalaya mine.*—The Himalaya mine, about 3 miles northwest of Mesa Grande, is a remarkable producer of tourmaline from a small vein. The pegmatite varies from 18 inches to 4 feet in thickness and has been traced several hundred yards. It has a strike of about N. 70° W., and a dip of over 20° SW., and cuts through a hill near the top. This vein has been worked by a large amount of open cut with several drifts on the vein at different levels. Part of the later work has been in a drift 300 feet long on the north side of the hill. The ledge exposed in this tunnel had a marked banded structure, consisting of streaks 3 inches thick with black tourmaline crystals roughly perpendicular to the walls on each side of a pegmatite band 18 inches thick and containing pockets with pink gem and black tourmaline. Crystals of quartz, feldspar, lepidolite, etc., are associated with the tourmaline. Other recent work consists of a crosscut tunnel on the south side of the hill, in which good ledge material was located. Drifts were to be run in each direction on this part of the vein.

*Mesa Grande Consolidated Gold and Gem Mining Company.*—The Mesa Grande Consolidated Company is operating a mine one-third of a mile south of the Himalaya mine. The recent work consists of an incline about 100 feet deep with drifts and stopes on the sides. Two shafts were formerly sunk to the northwest with drifts and stopes between them. The pegmatite varies from 6 inches to 3 or 4 feet in thickness and strikes northwest with a southwest dip. Mostly pink tourmaline was being found at the time of the writer's visit. Some of this was first-quality gem material; other was suitable for cabochon cuts.

*Esmeralda and Trail mines.*—The Esmeralda and Trail mines are about a mile and a half north of west of the Himalaya mine. The Esmeralda mine is evidently on a large pegmatite formation or on several arms of pegmatite. Considerable work has been done in the form of tunnels, cuts, and prospect pits. Biotite and black tourmaline are plentiful in the pegmatite. Beautiful pink and aquamarine beryl and some varicolored tourmaline have beeen found at this mine. At the Trail mine, on the same ridge and just above, the pegmatite carries dark-blue, nearly black tourmaline and much rough muscovite. Beryl crystals are said to have been found here.

*Cota mine.*—The Cota mine is about one-third of a mile southwest of the Himalaya mine, and the vein consists of a blanket ledge of pegmatite on the hillside. It is from 2 to 5 feet thick and strikes northeasterly with a light southwesterly dip. The ledge is banded with several textures, as seen in one exposure. It contains black, green, and blue tourmaline, with some of slightly pinkish color. Small hyacinth garnets and a pink clay occur in the vein. The gem minerals occur in streaks or long pockets.

*Rose Quartz mine.*—The Rose Quartz mine, on a narrow, high spur or ridge, is 4 miles N. 60° W. of Mesa Grande. The ledge at this mine is marked by a large outcrop of pale, translucent rose and white quartz. The pegmatite is probably over 35 feet wide and contains quartz segregations 20 feet wide in places. Feldspar also occurs in nearly pure masses 6 to 8 feet through. Large black tourmaline crystals 2 to 5 inches in diameter and several feet long occur in the pegmatite. The only gem mineral so far found has been a very dark reddish hyacinth garnet.

### RAMONA.

*Little Three and Surprise mines.*—The Little Three mine on the northwest and the Surprise mine adjoining on the southeast are situated near the foot and on the south side of a hill, 4 miles N. 70° E. of Ramona, on which a number of gem mines have been located. The pegmatite ledge at these mines has a northwesterly to north of west strike with a dip of 25° SW. The pegmatite varies from 3 to 10 feet in thickness, a portion consisting of finer-grained, banded pegmatite. Some of the gem minerals are found in pockets, while others are frozen in the vein matter. The pockets vary from 1 or 2 feet long and 2 or 3 inches wide to 20 feet long and 12 to 18 inches wide. The gem minerals found are hyacinth garnet, topaz of white, pale-greenish, bluish, and yellow color, tourmaline, and beryl of white, green, and pink color, associated with clevelandite, orthoclase, muscovite, biotite, and fine quartz crystals. Much very fine specimen material is obtained. The mines are worked by open cuts after the vein has been stripped of overlying rock.

*Hercules and Lookout mines.*—The Hercules mine is part way up the hillside to the northeast of the Little Three, and the Lookout mine is still farther northeast, extending to the top. The Hercules mine has been worked by a cut and a tunnel 90 feet long. The Lookout mine has been opened at two points by open cuts, one on top of the hill, the other 200 or 300 feet below the top, where the ledge has been stripped through a height of about 75 feet. The Hercules mine contains hyacinth garnet, beryl, tourmaline, and smoky quartz crystals. The Lookout mine has yielded chiefly beautiful hyacinth garnet, though a pocket of green tourmaline has been opened at the top of the hill.

*Daggett mine.*—The Daggett mine is about half a mile northwest of the Little Three mine. It has been worked as extensively as any of the mines in this district, with several tunnels and a small amount of stoping. The pegmatite is nearly in the form of a blanket ledge on the hillside with a northerly strike and a dip of 35° W. The gems found were pink beryl, green tourmaline, some very dark, and hyacinth garnet, associated with lepidolite, muscovite, biotite, albite, orthoclase, and quartz.

*Other mines.*—A few hundred yards to the north of west of the Little Three mine are the Reliance and the Mars claims. There are two ledges on the Reliance claim. These ledges were being prospected during 1907 with the result that a little hyacinth garnet, some green tourmaline, and frozen beryl were found. The pegmatite in one of these ledges exhibits a marked banded structure, due to the occurrence of certain minerals, especially tourmaline, in parallel layers. A small amount of hyacinth garnet was found during prospecting work on the Mars claim during 1907.

## CUTTING AND SALE OF GEMS.

Several of the companies mining precious stones in southern California have their own lapidary establishments and cut for the local trade and for the markets at a distance. These lapidary establishments are located in Los Angeles, San Diego, and other towns. Some of the cutting shops employ but one or two men, while others keep from five to ten men busy. In San Diego there were at least six of these establishments in operation during 1907, employing from one to six men. Some of these lapidaries work with improved mechanical methods, cutting faceted stones of perfect symmetry and great beauty. Carborundum is principally used for cutting and oxide of tin or chromium for polishing the gems.

The gems bring good prices in the cities of California. Tourmaline of finest quality and facet cut are sold for from $6 to $15, and even as high as $20 per carat, according to size. Flawed tourmaline suitable for cabochon cuts is sold for 50 cents to $1 per carat, according to quality and size. Kunzite is sold for slightly less than tourmaline, though practically the same price is sometimes paid for exceptionally fine, rich, lilac-colored gems. Hyacinth garnet is ordinarily sold for from $3 to $10 per carat, though in some cases higher prices are obtained. Beryl brings from $2.50 to $15 per carat, according to quality and size. Pink beryl of good quality is sold for about $8 per carat. Considerable turquoise, obtained from Arizona, Nevada, and California, is also cut and sold by the lapidaries. The one-color blue gems bring from $3 to $10 per carat and matrix stones from 25 cents to $1 or more.

## THE GEMS OF NORTH CAROLINA.

An admirable treatise on the "History of the gems found in North Carolina," by Dr. George F. Kunz, has recently appeared as Bulletin No. 12 of the North Carolina Geological and Economic Survey. The report is illustrated with fifteen plates showing specimens of gems, their associated minerals, and occurrence. Four of the plates are beautifully colored, showing either rough or cut gems, or both, of ruby, sapphire, diamond, beryl, aquamarine, emerald, hiddenite, smoky and rutilated quartz, amethyst, cyanite, and rhodolite garnet. Doctor Kunz calls attention to the fact that many of the gems of North Carolina have been found or obtained during mining for other minerals, as corundum, mica, monazite, etc. The history of events leading to the discovery of certain gems, as the emerald and emerald matrix on Crabtree Mountain, Mitchell County, and the emerald and hiddenite deposits of Alexander County, is given. The occurrence of ten authentic finds of diamonds and several reported discoveries are carefully reviewed. The corundum gems, or ruby and sapphire, beryl gems, or aquamarine and emerald, hiddenite, quartz gems, as amethyst, rock crystal, smoky, rutilated quartz, etc., and garnet, receive the most attention. Other gems, as moonstone, rutile, cyanite, etc., are mentioned. The coloring of the different gems is well described.

## GEM MINERALS OF CANADA.

A few notes on the gem minerals of Canada have been kindly furnished by the director of the geological survey of Canada, through Mr. R. A. A. Johnston, a mineralogist of that survey. The following minerals have been found as recorded:

Beautiful pinkish colored and clear white apophylite in the mines of Rossland, British Columbia.

Pale to dark blue colored amblygonite in small masses near Lake Ramsay, Lunenburg County, Nova Scotia.

Aventurene, composed of amazon stone interlaminated with quartz, on lot 7, concession A, Cameron Township, Nipissing district, Ontario.

Large crystal masses of translucent and clear sea-green colored fluorite in a vein near the village of Madoc, Hastings County, Ontario.

Fine green scales of fuchsite scattered through dolomites and magnesites in Yukon district. Polished specimens form handsome ornamental stone with greenish and reddish mottling in a groundmass of white or yellowish white.

Dark wine or cherry-red almandine garnets in large crystals in a hornblende schist south of Hudson Strait, Ungava district. Almandine suitable for gems is occasionally found in Chicoutimi and Charlevoix counties, Quebec.

Agate and chalcedony in many places in the volcanic rocks of Yale and Caribou districts, British Columbia. Small masses of prase at the head of Nicoamen River, Yale district, British Columbia. Morion quartz, in some cases an inch or two thick, in the vicinity of Lake Ramsay, Lunenburg County, Nova Scotia.

Vesuvianite, of a honey-yellow color, of fine gem quality, in the township of Harrington, Argenteuil County, Quebec.

Mr. H. S. Williams, of New York, reports a production of sodalite in British Columbia, from which locality 125 pounds were obtained by himself and Mr. O. M. Harper.

## GEM MINERALS OF MADAGASCAR.

A report on the precious stones of Madagascar has been prepared by Albert Dabren,[a] mining engineer of the colony. The following is quoted from the abstract of this report by W. T. Schaller:[b]

> In pegmatites traversing crystalline schists are found the following gem minerals: Amethyst, zircon, sapphire, topaz, garnet, tourmaline, and beryl, the last two being mined as gems. The variously colored tourmalines—pink, green, blue, and colorless—are found in the pegmatites, which consist of quartz, mica, orthoclase, microcline (sometimes green), and albite. The associated minerals are lepidolite, garnet, yellowish green and pink spodumene, and pink, yellow, green, and pale-blue beryl. In some crystalline limestones are found green spinel, reddish, bluish, and greenish corundum, white diopside, and tremolite. In the important river alluviums occur corundum, spinel, yellow transparent chrysoberyl, topaz, beryl, almandine garnet, tourmaline, and quartz. Colored corundum is very abundant in certain alluvium deposits, being found here with the other gems above mentioned. These corundums have not as yet been found in place. They seldom yield cut gems of over a carat weight. Abrasive corundum is also found. Greenish blue kyanite is found in place in mica schist. Colorless, yellow, brown, or pink zircons, not found in place, are very abundant in the alluviums. They are too minute to be used in jewelry. In 1906 the exportation of precious stones amounted to 29,716 grams, of which 7,930 grams were tourmaline, 1,350 beryl, 1,135 garnet, and 1,000 rose quartz. The production of rough corundum from Analambato was 243,280 grams. The modes of occurrence, association, and especially the localities for the various minerals named above are described very fully in the paper.

## RADIUM AND CORUNDUM.

The experiments performed by Mr. F. Bordas on the action of radium on sapphire gems are of interest.[c] It was found that blue sapphire, exposed to radium bromide of 1,800,000 activity, changed to green, to yellow, and finally to dark yellow; while red sapphire changed to violet, to blue-green, to yellow. Mr. Bordas observes that the color is not destroyed by heat, though Mr. George B. Selden, jr., of Rochester, N. Y., in repeating these experiments[d] found that the yellow color was quickly destroyed by heating the sapphire to 800°. It is not thought these reactions will be commercially used, though they are scientifically interesting.

## PRODUCTION.

The production of precious stones in the United States during 1907 as reported to the Survey was much greater than during 1906. The values given in some cases are those estimated for an output of a known quantity of gems, and where possible the value of the rough material is represented, in accordance with the aim of the Survey. It is often impossible to obtain accurate figures in this form, since it can not be known what a certain lot of rough mineral will yield when selected and cut. Some of the figures of production furnished this office are evidently the values for elaborated gems, while others may represent but little more than the cost of mining. Aside from the difficulty experienced in obtaining figures from certain producers, there is a considerable production of various gems from scattered localities concerning which little information can be obtained.

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[a] The precious stones of Madagascar: Bull. économique, 4e trimestre, 1906. (Tananariva, Madagascar.)
[b] Chem. Abstracts, vol. 2, No. 7, Apr. 10, 1908.
[c] Mining Jour., London, November 9, 1907, and April 4, 1908
[d] Jewelers' Circ. Weekly, February 12, 1908.

The table shows an increased production of several minerals during 1907 over 1906. The most important increase is in the production of sapphire, which was mined in unusually large quantities in Montana. A substantial increase is recorded in the production of tourmaline and chrysoprase, and in several minerals produced in small quantities, as amazon stone, rose quartz, topaz, and utahlite and amatrice. A substantial production of californite was reported for 1907; no output was recorded for 1906. Several other gems are listed with a production in 1907 for which no record was obtained during 1906, as gold quartz, jasper, pyrite, smithsonite, etc. One new gem mineral from California, benitoite, was added to the list. Values of the production of such minerals as diamond in Arkansas, emerald and ruby in North Carolina, were estimated from outputs reported or seen.

*Production of precious stones in the United States in 1906 and 1907.*

| Precious stone. | Value. | | Remarks. |
|---|---|---|---|
| | 1906. | 1907. | |
| Agate, moss agate, etc | $800 | $650 | 6,000 pounds; Colorado and Washington. |
| Amazon stone | 100 | 1,025 | 2,300 pounds; principally from Colorado. |
| Amethyst | 700 | 850 | Chiefly from Virginia and North Carolina. |
| Azurmalachite | | 250 | Arizona and Nevada. |
| Benitoite | | 1,500 | Rough gem stock; California. |
| Beryl: Aquamarine, blue, pink, etc. | 9,000 | 6,435 | California, North Carolina, Colorado, Maine, Pennsylvania, and New Hampshire. |
| Californite | | [a] 25,000 | 5,000 pounds; California. Called jade. |
| Catlinite | | 25 | Pennsylvania. |
| Chiastolite | 25 | 20 | Massachusetts. |
| Chrysocolla | | 150 | Arizona and New Mexico. |
| Chrysoprase | [a] 32,470 | [a] 46,500 | 3,105 pounds; green and blue. |
| Cyanite | | 100 | North Carolina and Pennsylvania. |
| Diamond | | [a] 2,800 | About 200 carats, from Arkansas. |
| Diopside | 5 | | |
| Emerald | | [a] 1,320 | North Carolina. |
| Epidote | | 60 | Colorado and Pennsylvania. |
| Feldspar, moonstone, etc | | 85 | Pennsylvania and North Carolina. |
| Garnet: Hyacinth, pyrope, almandine and rhodolite. | 3,000 | 6,460 | California, Colorado, Arizona and New Mexico, South Dakota, and North Carolina. |
| Gold quartz | | 1,000 | Nevada. |
| Jasper | | 675 | 4,250 pounds; California and Colorado. |
| Opal | | 180 | Oregon, California, and Colorado. |
| Peridot | 2,400 | 1,300 | Arizona and New Mexico. |
| Petrified wood | 150 | 325 | 6,000 pounds; Colorado and Arizona. |
| Phenacite | 250 | 25 | Maine. |
| Prase | 50 | | |
| Pyrite | | 400 | Colorado. |
| Quartz: Rock crystal, smoky, rutilated, etc. | 3,050 | 2,580 | Several thousand pounds from various States. |
| Rose quartz | 4,000 | 6,375 | 51,300 pounds; South Dakota and Colorado. |
| Rhodocrosite | | 150 | 1,000 pounds; Colorado. |
| Ruby | 600 | 2,000 | North Carolina. |
| Rutile | | 200 | North Carolina. |
| Sapphire | 39,100 | [a] 229,800 | About 11,000,000 carats; Montana. |
| Smithsonite | | 800 | 200 pounds for cutting; many specimens. |
| Spodumene, kunzite, and hiddenite. | 14,000 | 14,500 | About 126 pounds; California and North Carolina. |
| Topaz | 1,550 | 2,300 | Utah, California, Texas, and Maine. |
| Tourmaline | [a] 72,500 | [a] 84,120 | 2,140 pounds; California, Colorado, Maine, and Connecticut. |
| Turquoise | 22,250 | [a] 23,840 | Arizona, Nevada, New Mexico, and California. |
| Variscite, amatrice, and utahlite | 2,000 | 7,500 | Utah. |
| Total | 208,000 | 471,300 | |

[a] Estimated.

## IMPORTS.

The importation of precious stones into the United States in 1907, as reported by the Bureau of Statistics, showed a large decrease from that of 1906. The greatest ratio of decrease was in the imports of pearls, which was nearly 72 per cent less than in 1906. The imports of uncut diamonds decreased nearly 29 per cent, and of cut, unmounted diamonds over 25 per cent. There was a marked decrease in the imports of other precious stones, though imports of glazier's diamonds and diamond dust or bort were both greater in 1907 than in 1906. The decrease was largely due to the panic of the last part of 1907, at which time the imports fell off heavily. The precious-stone industry during the first part of 1908 has been greatly depressed, though it is slowly recovering, as shown by the monthly imports.[a] In February the imports amounted to $200,443; in March to $389,514; in April to over $400,000, and in May to $463,454. These figures are far below those for 1906.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1903 to 1907, inclusive:

*Diamonds and other precious stones imported and entered for consumption in the United States, 1903-1907.*

| Year. | Diamonds. | | | | | Diamonds and other stones not set. | Pearls. | Total. |
|---|---|---|---|---|---|---|---|---|
| | Glaziers'. | Dust or bort. | Rough or uncut. | Set. | Unset. | | | |
| 1903 | $10,634 | $720,150 | $10,275,800 | $675 | $13,022,367 | $2,494,897 | $2,414,524 | $28,939,047 |
| 1904 | 73,054 | 445,621 | 10,234,587 | 559 | 13,439,023 | 1,893,969 | 1,142,150 | 27,228,963 |
| 1905 | 6,851 | 190,072 | 10,281,111 | 741 | 20,375,304 | 4,144,434 | 1,847,006 | 36,845,519 |
| 1906 | 104,407 | 150,872 | 11,676,529 | 305 | 25,268,917 | 3,995,865 | 2,405.581 | 43,602,476 |
| 1907 | 410,524 | 199,919 | 8,311,912 | ...... | 18,898,336 | 3,365,902 | 680,006 | 31,866,599 |

## PEARLS.

### UNITED STATES.

It was not possible to obtain a statement of the production of pearls in the United States, since a complete list of producers could not be obtained. There was, however, a considerable production of pearls and pearl-button shells in the Mississippi Valley region, and an estimate by Mr. Frank Koeckeritz, a large dealer in that region, is given. Mr. Koeckeritz estimates the production of pearls and slugs in 1907 at $264,500, as against $381,000 in 1906. The values given represent the first values at the point of finding the pearls before they have passed through the hands of dealers, jobbers, and retailers. The quality and prices remained about the same as during 1906, when white, cream, pink, purple, blue, and, rarely, black pearls of irregular, button, round, oval, pear, and drop shapes were found. The prices range from $1 to $2,000 each, and from $1.50 to $60 an ounce for slugs.

Mr. Koeckeritz estimates that 35,000 short tons of button shells were produced and sold during 1907 in the Mississippi region. The average price paid for these at the point of production was about $11 per ton, or $385,000, and about $586,250 at the button factories.

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[a] Jewelers' Circ. Weekly, June 19, 1908.

About 3,000 tons of "washboard" shells, hitherto not purchased by the button factories, were bought at about $5 per ton along the Illinois River, where their quality was found to be better than usual.

The exports of pearl shells to Europe were less in 1907 than 1906, since the domestic manufacturers paid better prices for them. The decrease in production was due to high waters during part of the season, a general late season in the spring of 1907, and to the cessation of the buying of shells at the beginning of the panic in the fall.

The National Association of Pearl Button Manufacturers place the production of pearl shells during 1906 at 48,000 tons, valued at $737,280.[a] A total of 25,200,000 gross of pearl buttons were turned out during 1906 by factories in 17 different States.

The United States Fish Commission has been engaged in an investigation of the habits and life of the mussel clam. It is hoped that the information collected on this subject will lead to passage of laws to protect the mussel clams and to aid in their artificial propagation. At the present rate of destruction of the mussels and of waste of pearl shells, it will be but a few years before the mussels will be practically exterminated.

Mr. Frank Koeckeritz states that the pearl fisheries were very scattered in 1907. In the early part of the season the Wabash River was worked by a large number of fishers. The Illinois River soon became prominent, however, and attracted crowds of mussel diggers. There was greater activity along the Mississippi River, the White and the Black rivers in Arkansas, and the Cumberland River, than for some years.

There was some pearl fishing in many other rivers in different parts of the United States. Mr. Alfred Scholten reports a small output from the Colorado River between Blufton and Tow, Tex.

Several large pearls, valued at between $1,000 and $2,000, were reported during 1907. One of these was found near New Albany, Ind., in the Ohio River, and was one-half an inch in diameter.[b] It was slightly flattened on one side and perfectly oval on the other. Another pear-shaped pearl, weighing about 87 grains, was found near Williamsport, Ind.[c] The owners expected to realize $2,000 for it. A very large pearl, weighing 165½ grains, was found near Dubuque, Iowa. It has been valued at between $2,000 and $6,000.

## MEXICO.

According to Consul W. D. Shaughnessy, of Aguascalientes, a Mexican company is successfully cultivating pearls in the Gulf of Lower California.[d] It is said a man named Vives discovered that the pearl developed in about two years' time, when the shell dropped it out. Accordingly, the shellfish are protected from the time they are hatched and opened when nearly two years old before the pearl has been lost.

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[a] A few notes upon the pearl button industry of America: Nat. Assoc. Pearl Button Manufacturers U. S. of America.

[b] Manuf. Jeweler, September 5, 1907.

[c] Manuf. Jeweler, August 1, 1907.

[d] Daily Cons. Repts., March 30, 1908.

# QUARTZ AND FELDSPAR.

By Edson S. Bastin.

## QUARTZ.

### INTRODUCTION.

Quartz, the most abundant of all minerals, occurs in a great variety of forms and is utilized commercially in many different ways. Certain transparent colored varieties, such as rose and smoky quartz and amethystine quartz, have a gem value and are discussed in the chapter on precious stones. Sand used for building, molding, and in glass and pottery manufacture, is also discussed in other parts of this volume, as are tripoli and sandstone and quartzite used for building purposes, and quartz used as an abrasive, although all these materials are nearly pure quartz. This chapter deals only with massive crystalline quartz (often called vein quartz), with flint, and with quartzite which is used for other than building or paving purposes.

### MASSIVE CRYSTALLINE QUARTZ.

Quartz of this variety is usually white, though occasionally rose colored or smoky. It occurs in vein or dikelike masses, unmixed with other minerals, or as a constituent of pegmatite. In the latter occurrence it is produced as an accessory in the mining of feldspar. The States now producing massive crystalline (vein) quartz in commercial quantity are Connecticut, Illinois, Maryland, New York, and Pennsylvania. Small quantities were formerly marketed from Maine, but these quarries are so far from the principal markets that the quartz can not now be sold at a profit.

### QUARTZITE.

This rock may be described as a sandstone in which the spaces between the quartz grains have been completely or almost completely filled, either through a further deposition of quartz between the grains or through a recrystallization of the quartz of the original grains. The result is a solid mass of quartz. In Cherokee County, N. C., a hard, vitreous quartzite of Cambrian age is extensively quarried for use as a flux in copper smelting.

## FLINT.

The name flint is properly applied only to quartz of exceedingly compact texture, dull surface, and perfectly conchoidal, splintery fracture. It commonly occurs in the form of more or less irregular nodules in limestones. Chert is another name applied to flint occurring in this way. Flint or chert nodules occur abundantly at several localities in the United States, notably in the Cretaceous limestones of central Texas, a locality in the west portion of the city of Austin being the most accessible. So far as known very little domestic flint has ever been commercially utilized except as road material, though its quality appears to be equal to that of the imported flint. All the true flint consumed in this country comes from France, Greenland, Norway, and England, and is imported cheaply as ballast. Many of the smaller and nearly spherical nodules are used in tube mills, but much of the material is fired in kilns and then ground for use in the pottery trade. The flints, which are usually gray to nearly black in their natural condition, become perfectly white on burning and fracture somewhat, so that grinding is facilitated.

## METHODS OF GRINDING.

In the grinding of the massive forms of quartz two general processes are used, which may be called the "wet process" and the "dry process."

In the wet process the quartz may be crushed just as it comes from the quarry, or it may first be highly heated in kilns and then fractured by turning upon it a stream of cold water. The first crushing is effected by jaw crushers or if the quartz has previously been burned it may be crushed in chaser mills. In a few mills the chasers revolve in wet pans and are periodically stopped to allow the crushed quartz to be shoveled out. After crushing, it is ground in "wet pans" provided with a pavement of flat-faced quartz or quartzite blocks over which move several large blocks of similar material, the crushed quartz being pulverized between these blocks and the pavement. The grinding in wet pans usually occupies about twenty-four hours, the load ground in a single pan varying from 1,200 to 1,800 pounds. From the wet pans the paste-like mass of quartz and water is drawn into settling troughs, first settlings being in some cases returned to the pans for finer grinding. From the settling troughs it is shoveled out upon drying floors heated by steam or hot air or else is dried in small pans which are placed tier on tier on heated racks constructed of steam pipes. Finally the dried material is bolted to various degrees of fineness and packed in bags for shipment, or it may be shipped in bulk.

In the dry method of treatment the quartz is usually crushed first in a jaw crusher and then between steel rollers, though in some cases it goes from the jaw crushers to a gyrating crusher before passing to the rolls. Quartz to be used for filters and for abrasive purposes is then screened to various degrees of fineness, usually through revolving screens, and is packed in bags for shipment. In the manufacture of the finer grades for use in pottery, wood fillers, scouring soaps, etc., the material after leaving the roll crushers is ground in tube mills, either of the continuous or of the intermittent type. It is then graded to various sizes either by bolting or by a pneumatic process whereby the quartz powder is carried by a strong air current through a series of tubes and receptacles, the distance to which the quartz is carried being dependent on its fineness.

### USES.

Quartz of the kinds dealt with in this report is used for a great variety of purposes, the principal uses being in the manufacture of wood filler, pottery, paints, and scouring soaps. In pottery the quartz serves to diminish shrinkage in the body of the ware and is used also in many glazes. Quartz for these purposes should be nearly free from iron-bearing minerals. In general the analysis should show less than one-half of 1 per cent of iron oxide. Finely ground quartz is used in paints in various proportions up to one-third of the total pigment used. Its chemical inertness prevents it from combining with other constituents of the paint and increases the resistance of the paint to the weather. Crystalline quartz is superior to silica sand for this purpose because the ground particles are highly angular and tend to attach themselves more firmly to the painted surfaces, thus giving the paint what is known as a "tooth" and after some wear affording a good surface for repainting. This angularity of the grains also renders the ground crystalline quartz superior to silica sand in the manufacture of wood fillers. In scouring soaps and polishers ground crystalline quartz is preferred to silica sand, not only because of its greater angularity, but because of its superior whiteness.

Massive quartz, crushed and graded to various degrees of fineness, is extensively used in the manufacture of sandpaper, sand belts, as a scouring agent with sand-blast apparatus, etc. The qualities which render it particularly serviceable for these purposes are its hardness (No. 7 in the Mohs scale), which is slightly greater than that of steel, and its conchoidal fracture, the absence of definite cleavage planes causing it to crush to fragments with sharp, angular edges and corners. For such abrasive purposes massive quartz is far superior to sand or crushed sandstone, since the grains of the latter are likely to be more or less rounded. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and to some extent as a flux in copper smelting. Much ground quartz is used in filters, and some of the most finely pulverized grades are used in tooth powders and in place of pumice as a cleaner by dentists.

Within recent years crystalline quartz and also sand has been used to some extent in the manufacture of silicon and ferrosilicon by electrolytic processes, much of the output being produced at Niagara Falls. The metal silicon, which is a crystalline metallic substance of bright silver luster, has a specific gravity of about 2.49 and a melting point of about 1,430° C. Various grades are produced, running from 90 to 98 per cent silicon, the purity depending for the most part on the purity of the crude materials used. It can readily be cast into rods, and because of its high electrical resistance, which is about five times that of carbon, it is used in the manufacture of rheostats and electrical heaters. Silicon and ferrosilicon are extensively used as a hardener in steel manufacture and in the manufacture of alloys for copper and bronzes. Another important use of metallic silicon promises to be in the manufacture of chemical ware, its resistance to nearly all acids, combined with the fact that it can be cast in molds, making it suitable for these purposes. Chemical ware made of fused quartz has been on the market for some time, most of it being of European make. These wares are usually white and semitransparent. They soften only above 1,400° C. (2,552° F.) and show great resistance to sudden changes of temperature, the coefficient of expansion being extremely small. The principal drawback to the use of these wares, especially in quantitative chemical work, is that the somewhat rough character of their surfaces makes it difficult to wash thoroughly all material from the dishes.

## LOCALITIES BY STATES.

### CONNECTICUT.

Three important quartz quarries, in addition to a number of small workings, were operated in Connecticut in 1907.

*New London County.*—Quartz is quarried at a single locality at Long Hill in the town of North Stonington. The material is hauled by team 8 miles to Mystic Bridge, where it is ground by the wet process. The following description of the deposit is adopted in part from the report by Rice and Gregory on the Geology of Connecticut.[a] The quartz deposit forms a conspicuous ridge whose southern and northern portions are known respectively as Long and Lantern hills. The whole crest of this ridge, with a width of 1,000 to 1,500 feet and a length of fully a mile, is made up of white crystalline quartz, frequently showing a banded structure trending a little east of north. The quartz mass is more or less porous and where exposed in the quarry is in part so disintegrated that it can be excavated with pick and shovel; though in other places blasting is required. The quartz at the mine is free from iron stains, the only impurity being occasional greenish micaceous particles, which do not, however, injure its commercial value. The analysis shows 98 per cent of silica. The most satisfactory theory of the origin of the deposit supposes it to have been formed through the gradual replacement of a banded granite nearly free from iron-bearing minerals. This is believed by Gregory to have taken place through the agency of heated silica-bearing waters ascending along fracture planes. The supply of material is enormous, and only its distance from the railroad (8 miles) prevents it from being more actively developed.

*New Haven County.*—Quartz is quarried in the western part of this county about 1¾ miles south of Southford station, the product being shipped by rail to mills near New Milford, Litchfield County, and at Branchville, Fairfield County. The quarry is a single pit about 200 feet long, 100 feet in maximum width, and 50 feet in maximum depth. The deposit is a typical granite-pegmatite (see page 13), bearing potash feldspar, muscovite, black tourmaline, beryl, etc., in addition to the quartz which is its principal constituent. The feldspar at this quarry is of excellent quality. The quartz is very pure and varies from white to pale rose color. Some of the masses of pure quartz are 30 feet across. The present exposures show no evidence of the dying out of the pegmatite mass in any direction and give no indication whether it is flat lying or steeply inclined. The material is excavated by steam drilling and blasting, and the lump quartz hauled by team 1¾ miles to the railroad at Southford.

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[a] Bull. No. 6, State Geol. and Nat. Hist. Survey, Connecticut, 1906, pp. 136-138.

*Litchfield County.*—One of the large quartz quarries of the State is located about 2 miles east of Roxbury station, in the town of Roxbury, the material being ground at a mill at Roxbury station. The quartz quarry is about 250 feet long, 75 to 100 feet wide, and 50 feet in maximum depth, its greatest dimension trending about N. 20° W. The quartz is typical vein quartz, massive and nearly pure white, and the only impurities are small lenses of talc and sericite. The exposures do not indicate the trend of extent of the deposit. At the mill the material (which is to be finely ground) is first burned in kilns to fracture it and to facilitate grinding. It is then crushed in jaw crushers, chasers, and crushing rolls, and ground in continuous-feed tube mills. After this it is graded to various degrees of fineness by air separators, which also remove most of the micaceous impurities. Some of the quartz is not finely ground but is crushed without previous burning and is graded to various degrees of fineness for use in filter beds and for sandpaper, sand belts, etc.

Small quantities of quartz are quarried about 3 miles north of Litchfield, the material being hauled 3½ miles to Litchfield station and shipped to mills near New Milford and at Branchville. The quartz here occurs in lens-shaped veins in the mica schists which occupy most of this region. The schists in general trend about N. 20° to 30° E., and dip to the northwest at about 45°. Most of the quartz veins have a similar trend and dip. None of the veins seen by the writer were over 30 feet in maximum width, and all appear to die out rapidly along their trend. Unless larger veins are discovered this district does not promise much for future development.

### NEW YORK.[a]

In New York State quartz is quarried in the vicinity of Bedford in Westchester County. It is white and rose color and occurs as a constituent of pegmatite, being quarried as an accessory in the mining of feldspar. The quartz from this district is hauled about 8 miles to Bedford station and shipped to mills at Branchville and near New Milford in Connecticut.

### MARYLAND.

*Howard County.*—A small quantity of quartz is quarried near Marriottsville, in Howard County, and is shipped in the crude state.

*Baltimore County.*—A small quantity of white quartz is quarried 1½ miles east of Woodstock. It occurs in pegmatite and is obtained as an accessory in the quarrying of feldspar. It is shipped in the crude state. The quartz mill of the Glen Morris Supply Company, located at Glen Morris, was destroyed by fire during the year and has not yet been rebuilt. This mill was supplied with white vein quartz from a large number of small workings operated by farmers in this vicinity. No fine grinding was attempted at this mill, only crushed material for use as filters and for abrasive purposes, etc., being produced.

*Carroll County.*—An important quartz quarry is located about 1¼ miles southeast of the small village of Louisville. Here there are two quarry openings on a southward sloping hillside. The lower one now being worked is about 100 feet long from northeast to southwest, 30 to 40 feet wide, and about 20 feet in maximum depth. The upper pit, not now worked, is slightly larger. The quartz is massive vein quartz almost entirely free from impurities. The deposit seems to trend about 30° E. and extends for over one-half mile along the upper slopes of this hill. The adjacent rock is much decayed near the surface, but seems to be a mica schist. The quartz is excavated by hand drilling and blasting. From the quarry it is hauled by team more than 5 miles to Finksburg Station, where the grinding mill is located. The quartz is first crushed in a jaw crusher and then between crushing rolls and in a centrifugal crusher. It is then ground in continuous feed tube mills and graded to various finenesses by air separators similar to those used in one of the Connecticut plants.

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[a] For a fuller description of the quartz and feldspar deposits of southeastern New York, see Quartz and feldspar: Mineral Resources U. S. for 1906, and also Bull. U. S. Geol. Survey No. 315, 1907, pp. 294-309.

*Harford County.*—A quartz quarry is located in the northeastern part of this county about 1½ miles west of Conowingo, Cecil County. Several large pits have been worked in this vicinity, the one now operated being about 150 feet long by 100 feet wide by 50 feet in maximum depth. Another pit now abandoned is 300 feet long by 200 feet wide by about 50 feet in depth. The material is massive white vein quartz very free from impurities. The relations of the quartz to the surrounding rocks is not well shown at most of these quarries, but at one the quartz forms a dikelike mass in serpentine; the quantity still available is unquestionably very large. The material is excavated by hand drilling and blasting and must be hauled by wagons 1½ miles to the mill across the Susquehanna River at Conowingo, where it is ground in wet pans and shipped to West Virginia potteries. The burning of the bridge across the river at this point has curtailed the output of these quarries somewhat during 1907.

Another quartz quarry is located about 1¼ miles southeast of Flintville. The quarry pit is about 200 feet long, from 50 to 100 feet in width, and 35 feet in maximum depth. The quartz is massive and has a slightly blue-gray tint. It is excavated by hand drilling and blasting and hauled by teams to the mill at Flintville, where it is ground in wet pans and marketed for pottery purposes.

The mill of the Diamond Flint Company (which is located on Deer Creek about 7 miles northeast of Bel Air) was destroyed by fire during the year. This company's quarry, which was located close to the mill, consists of a narrow pit about 300 feet long, from 40 to 75 feet wide, and about 35 feet in maximum depth. The quartz is opaque, white, and massive, and nearly free from impurities. A portion was crushed for abrasive purposes, but most of the material was ground in wet pans for use in the pottery trade.

### WISCONSIN.

Quartz has been mined since 1893 at Rib Hill about 2 miles southwest of Wausau in Marathon County. The rock here is a quartzite of pre-Cambrian age. It is mostly white, though occasionally pale pink due to a slight iron stain. It is hard and brittle and breaks with the conchoidal fracture usually found only in vein quartz. Its texture varies from medium to very coarse, the latter varieties being the principal ones mined. Two firms have operated this deposit but the mill of one of these concerns was consumed by fire during the year. The quartz is hauled by teams from the mines at Rib Hill 2 miles to

Wausau. The ground product is used for sandpaper and various other abrasive purposes and for filters, bird grit, wood filler, facings for artificial stone, etc. An analysis of the quartzite rock from one of these quarries showed 99.07 per cent silica, 0.52 per cent alumina, and 0.17 per cent iron, and this may be considered as representative of most of the material mined. The iron percentage in this sample is considerably lower than that in a number of sands used for pottery purposes, and is only slightly higher than that in some crystalline quartz used for pottery.

### OTHER STATES.

*Pennsylvania.*—In Pennsylvania quartz used in the manufacture of sandpaper is mined near Glenmoore in Chester County and is shipped crude to Philadelphia. Another quartz mine and mill is located near Bendersville in Adams County, the product being used principally for pottery and abrasive purposes.

*Massachusetts.*—A small quantity of crystalline quartz is quarried near Cheshire in Berkshire County, Mass., and near Blandford in Hampden County.

*North Carolina.*—In North Carolina quartz is extensively quarried near Ranger in Cherokee County and is shipped to Tennessee for use as a flux in copper smelting.

*South Carolina.*—A few hundred tons are mined in Fairfield County, S. C., ground within the State, and sold to jobbers in New York and Chicago.

*California.*—A small quantity is mined near Heroult in Shasta County, Cal., and is used in the manufacture of ferrosilicon.

*Illinois.*—In Illinois silica is quarried at a number of localities in Union and Alexander counties and ground at mills situated near the mines. The origin and extent of the Illinois deposits are imperfectly known, but they seem to represent the residue remaining from the decomposition of a siliceous limestone, and appear to be somewhat similar in their character and mode of formation to the tripoli deposits so extensively worked in Missouri.

*Missouri.*—The Missouri deposits are described and their production entered under the heading of tripoli, since the material is marketed under that name.

None of the quarries mentioned in this section have been visited by the writer.

### PRODUCTION.

In the following table the production of quartz is entered under the head of "Crude" or "Ground" according to the state in which it was first placed upon the market. Nearly the whole production is eventually ground or finely crushed.

*Production of quartz in the United States in 1907, by States, in short tons.*

| State. | Crude. | | Ground. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Connecticut and New York | 168 | $450 | 10,387 | $98,140 | 10,555 | $98,590 |
| Pennsylvania and Maryland | 948 | 1,985 | 4,392 | 27,702 | 5,340 | 29,687 |
| All others | 4,502 | 1,847 | 2,580 | 26,970 | 7,082 | 28,817 |
| Total | 5,618 | 4,282 | 17,359 | 152,812 | 22,977 | 157,094 |

*Production of quartz in the United States, 1902-1907, in short tons.*

| Year. | Crude. | | Ground. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 20,295 | $35,046 | 16,070 | $109,163 | 36,365 | $144,209 |
| 1903 | 40,046 | 38,736 | 15,187 | 118,211 | 55,233 | 156,947 |
| 1904 | 41,490 | 28,890 | 10,780 | 71,700 | 52,270 | 100,590 |
| 1905 | 39,555 | 33,409 | 11,590 | 70,700 | 51,145 | 104,109 |
| 1906 | 41,314 | 37,632 | 25,383 | 205,380 | 66,697 | 243,012 |
| 1907 | 5,618 | 4,282 | 17,359 | 152,812 | 22,977 | 157,094 |

The notable decrease in the production of crude quartz is due in part to an actual decrease in the quantity quarried and in part to the fact that certain quartz properties have been purchased or leased by quartz millers, so that material formerly placed on the market in the crude state is now marketed as ground quartz. In spite of this accession from the list of quartz formerly marketed in the crude state, and in spite also of the fact that a number of new names were added during 1907 to the Survey's list of quartz millers, the figures record a decrease in the production of the ground material. This is due in part to the fact that three important quartz mills were destroyed by fire during the year, but also to a decrease in the production of nearly all the other companies, caused in large measure by the financial stringency. The market conditions were generally reported as good until September or October, and as very unfavorable during the remainder of the year.

The total production of quartz in 1907, including quartz used for abrasive purposes, amounted to 33,162 short tons, valued at $223,801.

*Imports.*—The imports of flint and flintstones into the United States during 1907 were valued at $288,371 (unground), as against $272,607 in 1906 and $146,463 in 1905.

## PRICES.

Pure crystalline quartz for use in the manufacture of pottery, abrasive soaps, paints, wood fillers, etc., brings usually about $2 to $3.50 per long ton, crude, free on board at the quarries, and the ground material brings from $6.50 to $10 per short ton free on board at the mills, the price varying with the fineness of grinding, distance from markets, etc. The purer varieties of quartzite used for similar purposes and for sandpapers sell, as a rule, at somewhat lower prices, the crude bringing about $1.50 to $2 per long ton free on board at the mines and the ground from $6 to $8 per short ton free on board at the mills. The finest grades of crystalline quartz ground to an impalpable powder and used for tooth powders, etc., may bring as high as $20 per ton free on board at the mills.

## FELDSPAR.

### CHEMICAL AND PHYSICAL CHARACTERS.

The feldspars are compounds of alumina and silica with one or more of the bases potash, soda, and lime—rarely barium is present. They fall into two principal groups—the potash-soda feldspars and the lime-soda feldspars—both of which may be present in the same deposit or even intergrown in the same crystal.

### POTASH-SODA FELDSPARS.

The principal representatives of the potash-soda feldspar group are orthoclase and microcline, both of which have the composition $KAlSi_3O_8$ or $K_2O.Al_2O_3.6SiO_2$. These two varieties have also the same crystal form and are similar in most of their physical properties. For commercial purposes they may be regarded as identical, since they can not be distinguished from each other with the unaided eye and are often associated in the same crystal. The theoretical percentage composition of pure orthoclase or microcline is as follows—silica ($SiO_2$), 64.7 per cent; alumina ($Al_2O_3$), 18.4 per cent, and potash ($K_2O$) 16.9 per cent. Soda may partially or completely replace potash in these feldspars. If it dominates over potash the feldspar is called anorthoclase.

The feldspars of the potash-soda group mined in the United States are mostly pale flesh colored to nearly white, though the rock from Bedford, N. Y., is reddish and that from near Batchellerville, N. Y., a pearl gray. The potash spars from Norway and from Bedford, Ontario, are reddish in color. The cause of the reddish color is not definitely known, but it seems in some cases to be due to the presence of small quantities of finely divided iron oxide. In many cases, however, the percentage of iron oxide is smaller in the pink feldspars than in those of lighter color. All the pink spars burn perfectly white, and the iron percentage is too small to be in the least detrimental in pottery manufacture. The hardness of fresh feldspar is such that only with difficulty can it be scratched with a knife blade.

As found in the quarries, the potash-soda feldspars seldom show true crystal faces, but when undecomposed break readily into angular pieces, bounded in part by smooth cleavage faces. There are three directions of cleavage, intersecting at definite angles, which are identical for orthoclase and microcline and change only slightly with an increase in the soda content. Only two of the cleavages are well defined, and these always intersect approximately at right angles. Both of these principal cleavage surfaces show a high luster, comparable to that exhibited by a plate of glass, though one cleavage face is a trifle less brilliant than the other. The hardness and the two lustrous cleavage planes intersecting at an angle of 90° are usually sufficient to identify the mineral as belonging to the group of potash-soda feldspars.

Recent experiments[a] have shown that the potash-rich feldspars do not possess a definite melting point—as do the metals, for example—but pass gradually from the solid state to that of a very stiff fluid. In most of the determinations that have been made complete fusion has taken place in the dry state at temperatures below Segar cone No. 9, which fuses at 1,310° C. or 2,390° F.

The great bulk of the feldspar quarried in the eastern United States and in Canada is orthoclase or microcline or an intergrowth of these two. In most quarries it is associated with minor quantities of the soda feldspar, albite (see below) occurring either as separate crystals or delicately intergrown with the potash feldspar. The presence of the soda spar renders the ground product slightly more fusible.

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[a] Day, A. L., and Allen, E. T., The isomorphism and thermal properties of the feldspars: Am. Jour. Sci., vol. 19, February, 1905, pp. 98-100

## LIME-SODA FELDSPARS OR PLAGIOCLASES.

The lime-soda group of feldspars, or plagioclases, as they are called, form a continuous series ranging from the pure soda feldspar, albite, at one end to the pure lime feldspar, anorthite, at the other end. The chemical composition of albite is represented by the formula $NaAlSi_3O_8$ (designated Ab) or $Na_2O.Al_2O_3.6SiO_2$, being similar to orthoclase, except that soda is present in place of potash. The composition of anorthite is represented by the formula $CaAl_2Si_2O_8$ (designated An) or $CaO.Al_2O_3.2SiO_2$. The intermediate members of this feldspar series are mixtures in varying proportions of the two molecules designated above Ab and An and have been divided arbitrarily, as shown in the following table:

*Lime-soda series of feldspars.*

| | | | |
|---|---|---|---|
| Albite | $Ab_1\ An_0$ to $Ab_6\ An_1$ | Labradorite | $Ab_1\ An_1$ to $Ab_1\ An_3$ |
| Oligoclase | $Ab_6\ An_1$ to $Ab_3\ An_1$ | Bytownite | $Ab_1\ An_3$ to $Ab_1\ An_6$ |
| Andesine | $Ab_3\ An_1$ to $Ab_1\ An_1$ | Anorthite | $Ab_1\ An_6$ to $Ab_0\ An_1$ |

The following table shows the percentages of the various oxides corresponding to each feldspar variety:

*Percentage weights of the oxides in the feldspars in the lime-soda series.*

| | $SiO_2$. | $Al_2O_3$. | $Na_2O$. | CaO. |
|---|---|---|---|---|
| Albite, $Ab_1An_0$ | 68.7 | 19.5 | 11.8 | 0.0 |
| $Ab_6An_1$ | 64.9 | 22.1 | 10.0 | 3.0 |
| $Ab_3An_1$ | 62.0 | 24.0 | 8.7 | 5.3 |
| $Ab_1An_1$ | 55.6 | 28.3 | 5.7 | 10.4 |
| $Ab_1An_3$ | 59.3 | 32.6 | 2.8 | 15.3 |
| $Ab_1An_6$ | 46.6 | 34.4 | 1.6 | 17.4 |
| Anorthite, $Ab_0An_1$ | 43.2 | 36.7 | .0 | 20.1 |

The field and microscopic studies made by the writer and the few available analyses indicate that most of the plagioclase present in feldspar deposits worked for pottery purposes is of the soda variety, albite, though some of the calcium-bearing varieties are probably also present in a few localities. Albite is usually pure white. In its commonest form it shows, as do the feldspars of the potash-soda group, two principal cleavage faces with brilliant lusters, but they intersect not at 90°, as in orthoclase and microcline, but at about 86°. This difference in angle is not readily recognizable without careful measurements, and in the field the albite and others of the lime-soda group are most readily distinguished from the potash-soda feldspars by the presence in them of faint, perfectly straight striations on the most brilliant of the cleavage faces. These are the result of repeated twinning of the crystal, and are best seen by holding the crystal in the sunlight so as to catch the reflection from the principal cleavage face. By turning the crystal slightly one way or another the striations, if present, are readily recognized.

Pure soda spar or albite ($Na_2O.Al_2O_3.6SiO_2$), like orthoclase and microcline, has no fixed melting point, but passes gradually from the solid to the liquid state. It seems to be completely fused, however, at a temperature near 1,300° C. (2,372° F.), or about the melting point of Segar cone No. 9. Certain feldspar grinders mix soda feldspar with potash feldspar before grinding. The resulting product has a somewhat lower melting point—that is, forms a "softer" spar than the pure potash feldspar. With increase in the percentage of calcium the melting point rises, pure anorthite ($CaO.Al_2O_3.2SiO_2$) melting only at 1,532° C. (2,790° F.).[a]

## MODE OF OCCURRENCE.

The feldspars are among the most widely distributed minerals and occur as constituents of nearly all rocks. In these occurrences, however, the feldspar is usually in too small grains and too intimately associated with other minerals to be of commercial importance. Commercial feldspar usually occurs as a constituent of pegmatites. These are rocks of extreme coarseness and irregularity of texture. In mineral composition they may vary greatly, but those of present commercial importance belong chiefly to two types—(1) the granite pegmatites, which are essentially giant granites, their minerals being the same as those most abundant in ordinary granites, namely, quartz, potash-feldspar, muscovite, biotite, tourmaline, etc.; and (2) the soda pegmatites, which contain no quartz, no tourmaline, and little or no mica, but consist mainly of the soda feldspar, albite, with small quantities of hornblende. By far the larger number of the feldspar quarries of the United States are in deposits of granite pegmatite; only a few in southeastern Pennsylvania and adjacent parts of Maryland belong to the soda pegmatite type.

Pegmatites occur in or near most areas of crystalline rocks, usually as dikelike masses, following whatever planes of foliation or easy fracture may be present in the surrounding rocks, though in some cases cutting across these and often forming irregular bodies of considerable size. Different pegmatite masses even in the same region often differ considerably in coarseness, and even a single mass may vary greatly in coarseness from point to point. In general only a small part of the pegmatitic material of a region is sufficiently coarse grained or sufficiently free from iron-bearing minerals to be of commercial value. The geologic evidence generally supports the view that the pegmatite is really but one type of igneous intrusion, the molten rock magma being characterized by the presence of large quantities of gases or water vapor, which facilitated the formation of large crystals. The relative proportions and the quality of the different pegmatite constituents vary in different deposits, some being valuable chiefly for their mica, others for their quartz, and others for their feldspar. In some, two or all three of these minerals can be exploited. In a few cases the pegmatite is exploited principally for its gem minerals and its compounds of the rare metals.

The feldspar may occur as large crystals, occasionally 15 to 20 feet across, unmixed with other constituents, or they may be intergrown with quartz or with other minerals. The intergrowth with quartz is in some cases irregular, but in other cases it consists of crystals of quartz and feldspar, from several inches to several feet across, which penetrate one another in such a manner that on certain cleavage faces of the feldspar the quartz forms peculiar patterns somewhat resembling the cuneiform inscriptions on ancient monuments. To such intergrowths the name "graphic" granite has been given, from the Greek verb *graphein*, to write. Analyses of many specimens of graphic granite have shown that it is characterized by a very nearly constant proportion between the quartz and the feldspar, the feldspar forming from 70 to 80 per cent of the rock and the quartz from 20 to 30 per cent. Two specimens of a graphic intergrowth of potash feldspar and quartz analyzed in the laboratory of the United States Geological Survey showed, respectively, 72.9 and 73.7 per cent of feldspar, with 27.1 and 26.3 per cent of quartz, although one specimen was approximately four times as coarse as the other. A graphic intergrowth of potash feldspar and quartz from Elfkarleö, in Sweden, which was so fine grained that the graphic structure could be seen only under the microscope, showed upon analysis about 79.2 per cent of feldspar and 20.8 per cent of quartz.

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[a] Day and Allen, op. cit., p. 107.

The finer-grained types of graphic granite are utilized commercially in some districts, as, for example, in southeastern Pennsylvania; but among many feldspar miners the opinion prevails that the finer-grained varieties contain so much quartz as to render them commercially valueless. This opinion probably has its origin in their somewhat deceptive appearance, the fineness of grain causing them to appear richer in quartz than is actually the case. From the evidence furnished by analyses it would seem clear that from the commercial standpoint at least the proportion between quartz and feldspar in graphic granites of all textures may be regarded as nearly constant, so that the finer-grained types are as valuable commercially as the coarse. Graphic textures are not observed in any of the soda pegmatites.

### METHODS OF MINING.

The methods of feldspar mining are very simple. The excavations are nearly always open pits, usually of rather irregular form, the valueless portions of the pegmatite being avoided wherever possible in the mining work. In a few Pennsylvania quarries where the pegmatite masses are rather flat-lying and are overlain by a roof of worthless rock short tunnels have been driven from the open pits.

In Maine, Connecticut, and New York the pegmatite is usually firm and undecomposed, even in the surface outcrops, and it is necessary to sink drill holes and to blast out most of the material. In Pennsylvania and Maryland, however, the pegmatite is in most cases much decayed at the surface and the materials can frequently be excavated with the aid only of picks, shovels, and crowbars. In a few of these quarries kaolin produced by the decay of the feldspar has been found in the past in sufficient quantities to be of commercial importance, though none is now produced. This difference in the character of the pegmatite deposits in the two regions is due to the fact that the Pennsylvania-Maryland region is unglaciated, while in the more northerly region glacial ice planed off most of the products of rock decay.

In the smaller quarries where the rock is firm the drilling is usually done by hand, but in most of the larger quarries steam drills are used. The large masses are then broken with sledges into pieces about 6 inches in diameter, the more micaceous and quartzose parts and the portions carrying iron-bearing minerals being at the same time sorted out and discarded. In most of the Pennsylvania and Maryland quarries where the weathered materials near the surface can be excavated with the aid only of the pick and shovel, screening and sometimes washing is often necessary to separate the dirt from the spar. In some of the larger and deeper quarries derricks and drags are used in hoisting the spar to the surface, the material being then loaded into wagons and hauled either to the railroad for shipment or to the mills for grinding. In some quarries the wagons descend into the pit along an inclined roadway.

## COMMERCIAL AVAILABILITY OF DEPOSITS.

The question whether it will pay to work a given feldspar deposit depends upon a number of different factors, chief among which are (1) distance from the principal markets, (2) distance from the railroad, (3) quality and quantity of the material, (4) market conditions, and (5) ease of working. Favorable conditions with respect to some of these factors may counterbalance unfavorable conditions with respect to others. The deposits of Connecticut, New York, Pennsylvania, and Maryland are worked at a considerable advantage when compared with those of Maine, being much nearer the principal markets. Because of this advantage, hauls by team of 6 or 8 miles from the mines to the railroad are permissible in certain of the more southerly districts, while under present conditions in Maine a deposit to be worked profitably must usually be within 3 miles of a railroad or of navigable water.

The requirements of the potter's trade demand that in general the percentage of free quartz associated with the feldspar shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. In order to be profitably worked, in most feldspar mines between one-fourth and one-half of the total material which must be excavated should contain less than 20 per cent of free quartz.

A factor of the utmost importance is the quantity of iron-bearing minerals, black mica, hornblende, garnet, or black tourmaline, which is present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals, which if present produce brown discolorations in white wares. In order that a deposit may be worked profitably these minerals if present in any appreciable quantity must be so segregated in certain portions of the deposit that they can be separated from the spar without much more hand sorting and cobbing than is necessary in the separation of the highly feldspathic material from that which is highly quartzose or rich in muscovite. A number of pegmatite deposits of coarse grain are rendered worthless for pottery purposes by the abundance of one or more of these iron-bearing minerals. The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial feldspar, and chemically this mineral is not injurious. It is, however, exceedingly difficult to pulverize the thin, flexible mica plates to a fineness equal to that attained by the feldspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

## METHODS OF GRINDING.

The methods used for grinding feldspar are similar in a general way in all of the Eastern States and are very simple. The soda spar quarried in southeastern Pennsylvania is first burned in kilns, which serves to fracture it and thus facilitate grinding. Most feldspar, however, is fed just as it comes from the quarry into a chaser mill consisting of two buhrstone wheels about 3 to 5 feet in diameter and from 1 to 1½ feet thick, attached to each other by a horizontal axle, as are the wheels of a cart. The horizontal axle is attached at its center to a rotating vertical shaft, which causes the buhrstone wheels to travel over a buhrstone bed, the feldspar being crushed between the wheels and the bed. In a few mills the spar before going to the chaser mills is crushed in a jaw crusher.

The material as it comes from the chasers is screened, the tailings being returned to the chaser mills for recrushing, while the fines go to tube mills for their final grinding. The tube mills consist of steel cylinders revolving on a horizontal axis. They are usually lined either with hard-wood blocks or with blocks made of natural or artificial siliceous brick, and are charged with Norway or French flint pebbles 2 to 3 inches across. Feldspar for pottery purposes is usually ground for from four to six hours, and in that time is reduced to a fineness of at least 200 mesh. Some of the poorer grades of feldspar used in glass manufacture are ground only for from two to three hours, great fineness not being required in such material. Feldspar for use in abrasive soaps is sometimes ground for as much as ten hours. The type of tube mill used by most feldspar grinders is about 6 feet in length, and it grinds from 2 to 3 tons of spar at one charging. Certain millers, however, claim to effect a considerable saving in power by the use of larger mills, which grind from 4 to 6 tons at one charge. After grinding, the spar is ready for shipment either in bulk or in bags. The red spars from Bedford, N. Y., and Bedford, Ontario, have a faint pinkish tint when ground, but the cream-colored and white spars grind to a pure white. In a few mills the ground spar is allowed to settle slowly in water, so as to separate the finer from the coarser material, but this method is now rarely employed. Two hundred mesh to the inch is the figure usually given as the fineness required by pottery manufacturers, and it is probable that most of the material placed on the market comes within this limit.

In a new mill of large capacity recently erected near Middletown, Conn., the feldspar is crushed first in a gyratory crusher and then between steel rolls. It then goes to a rotary dryer and to aerial jig screens designed to free the material from mica flakes and iron-bearing minerals. After this it is ground in continuous-feed tube mills.

## USES.

The principal consumers of feldspar are the pottery and enameled brick and electrical ware manufacturers, its main application being as a constituent part of both body and glaze in true porcelain, white ware, and vitrified sanitary ware, and as a constituent of the slip (underglaze) and glaze in so-called "porcelain" sanitary wares and enameled brick. The proportion of feldspar in the body of vitrified wares usually falls between 10 and 35 per cent, though sometimes less and sometimes more. Its melting point being lower than that of the other constituents, it serves as a flux to bind the particles together. In glazes the percentage of feldspar usually lies between 30 and 50. The trade demands that feldspar for pottery purposes be nearly free from iron-bearing minerals (biotite, garnet, hornblende, tourmaline, etc.) and contain little if any muscovite. In regard to the percentage of free quartz, the requirements vary with different potters. A few manufacturers of the finer grades of pottery demand less than 5 per cent of free quartz, and may even grind the spar themselves so as to be sure of its quality, preferring to insure a constant product even at higher cost by themselves mixing the requisite quantity of quartz with the spar. Most potters get satisfactory results with "Standard" ground spar carrying 15 to 20 per cent of free quartz, and in some cases the percentage runs even higher. In the finely ground mixture as it comes from the mills it is difficult to separate the quartz from the feldspar by physical methods on account of the extreme fineness of the material. Chemical analysis seems to be the readiest means of determining whether its percentage is high or low.

Feldspar is also used in emery and carborundum wheel manufacture as a flux to bind the abrading particles together.

Small quantities of feldspar are used in the manufacture of opalescent glass. The feldspar used for this purpose is ranked as No. 3 by the miners; it usually contains more free quartz and muscovite than that used for pottery purposes, and in most cases also contains fragments of iron-bearing minerals. Most of the spars known to the writer which are used for opalescent glass are notably richer in soda than in potash. They are usually ground only to a fineness of 50 to 60 mesh.

Small quantities of carefully selected pure feldspar are used in the manufacture of artificial teeth. Some is used in the manufacture of scouring soaps and window washes, the fact that feldspar is slightly softer than glass rendering these soaps less liable to scratch windows or glassware than are the soaps in which quartz is the abrasive substance. One firm in New York State crushes pegmatite for poultry grit and for a covering for concrete and tarred surfaces to give the appearance of granite.

Much interest has recently been aroused in the use of potash feldspar for fertilizing purposes. Potash is an important plant food, which, in fertilizers, has usually been applied in the form of wood ashes or of easily soluble potash salts (sulphate, carbonate, or chloride) imported from Germany. The Department of Agriculture has recently conducted preliminary experiments to determine the availability of finely ground potash feldspar as a substitute for the more soluble potash salts. The following statement is quoted from the report on these tests:[a]

> The evidence so far obtained appears to indicate that under certain conditions and with certain crops feldspar can be made useful if it is ground sufficiently fine. On the other hand, it is highly probable that under other conditions the addition of ground feldspar to the land would be a useless waste of money. At the present stage of the investigation it would be extremely unwise for anyone to attempt to use ground rock, except on an experimental scale that would not entail great financial loss.

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[a] Cushman, Allerton S., The use of feldspathic rocks as fertilizers: Bull. No. 104, Bureau of Plant Industry, U. S. Dept. Agriculture, 1907, p. 31.

If further experimentation shows that ground feldspar has a wide efficiency as a fertilizer, it will undoubtedly lead to the utilization of many of the pegmatite deposits which, because of insufficient coarseness, too large a percentage of quartz, or too great an abundance of iron-bearing minerals, are not valuable as a source of pottery material. Deposits of this kind, favorably situated with respect to the railroads, are numerous, especially in the vicinity of the active feldspar quarries. An equally important result will be the utilization of much of the material which is discarded at the present feldspar quarries.

A number of processes have been patented in this country for the dissociation of potash feldspar to obtain the more readily soluble potash salts, but none of these have as yet been successfully applied on a commercial scale. What is perhaps the most promising method effects the decomposition through electrolytic methods.[a]

## LOCALITIES BY STATES.

### MAINE.[b]

Six feldspar quarries were operated in Maine during 1907 by four companies. One large quarry and 1 small one located in the town of Topsham, Sagadahoc County, were operated by the Trenton Flint and Spar Company, and a small quarry near by was operated by the Maine Feldspar Company. The large quarry near Auburn, in Androscoggin County, was operated by the Maine Fledspar Company, while a smaller quarry near by, in the town of Poland, was worked to some extent by Mr. A. R. Berry. A third large quarry was operated by Golding Sons' Company in Georgetown, Sagadahoc County. A small quarry opened in 1906 near Hebron has ceased operation.

Practically all of the feldspar mined in the State is flesh-colored potash spar (orthoclase and microcline), soda feldspar being present only in small quantities. Quartz is usually associated with the feldspar in sufficient abundance so that the commercial product is classed as No. 2 spar. The principal iron-bearing impurities are garnet, black tourmaline, and black mica (biotite).

The feldspar quarried near Topsham and Auburn is ground in part at the mill of the Trenton Flint and Spar Company, in Topsham, and in part at the mill of the Maine Feldspar Company, in Littlefields, near Auburn. That quarried in Georgetown by Golding Sons' Company is shipped to the company's feldspar mills at Trenton, N. J., and East Liverpool, Ohio.

As appears from the table, the Maine production in 1907 showed a notable increase over that for 1906. So far as known, no new deposits were opened.

### MASSACHUSETTS.[c]

Small quantities of feldspar are mined at a single quarry near Blandford, in Hampden County, and shipped for grinding to Trenton, N. J.

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[a] Cushman, A. S., Extracting potash from feldspar. Min. World, June 22, 1907; also U. S. Patent No. 772612, October 18, 1904.

[b] For detailed description of the feldspar and quartz deposits of Maine, see Bull. U. S. Geol. Survey No. 315, 1907, pp. 383-393.

[c] This property has not been visited by the writer.

### NEW YORK.[a]

The most important quarries in New York which produce feldspar for pottery manufacture are located in Westchester County. The largest of these is situated near the village of Bedford, while a smaller one is located 2 miles to the south, in the town of Northcastle. Both are operated by P. H. Kinkle's Sons. The feldspar quarried at these localities is in part ground at the mill of this company at Bedford, and in part is shipped in the crude state. It is hauled by team 8 miles to Bedford Station, on the Harlem Division of the New York Central Railroad.

The feldspar quarried at Bedford is in part pink potash feldspar (orthoclase and microcline), but with this are associated small quantities of white soda feldspar (albite). Quartz occurs in large pure masses, which are utilized commercially, and also occurs intergrown with the feldspar. In the quarry 2 miles farther southeast the feldspar is flesh-colored potash feldspar (microcline), and is also associated with large masses of pure quartz. The principal associated minerals of both of these quarries are white mica (muscovite), black mica (biotite), black tourmaline, and garnet. The muscovite is not of commercial quality.

The feldspar shipped is of three grades: No. 1 consists of practically pure potash feldspar, almost entirely free from quartz; No. 2 contains somewhat more quartz and soda feldspar, but is free from iron-bearing impurities; No. 3 contains a still larger quantity of soda feldspar and some iron-bearing minerals, and is used principally in glass manufacture.

A new feature of the feldspar industry in New York is the development by the Claspka Mining Company, of Trenton, N. J., of a feldspar property near Northville, Fulton County. This has become an important producer of feldspar, which is shipped crude to Trenton, N. J. Feldspar properties are also being developed near Corinth by the Corinth Feldspar Company, near Crown Point by the Crown Point Spar Company, and near Ticonderoga by the Ticonderoga Feldspar Company.

### CONNECTICUT.

In the number of tons produced Connecticut ranks first in the list of feldspar-producing States. Eight quarries were actively operated in the State in 1907, all of them being located near the Connecticut River valley in Middlesex County and in the southern part of Hartford County. Three feldspar mills are located within the State, 2 at South Glastonbury, and 1 at White Rocks, near Middletown. Much of the feldspar, however, is ground outside of the State, being shipped by rail or by barges down the Connecticut River, and thence to Trenton and other pottery centers. All the active quarries were visited by the writer in November, 1907.

The oldest and largest feldspar quarry in the Connecticut Valley region is located in Hartford County near the Middlesex County line, and 2 miles south of South Glastonbury. North of this quarry for about a mile along the eastern slope of the Connecticut River valley are a number of abandoned quarries and one which is now operated. Another important quarry is located about 2¼ miles northeast of South Glastonbury, near the road to East Glastonbury. In Middlesex County active quarries are located on Collins Hill in the township of Portland, about 2 miles northeast of the village of Portland; in Chatham about 1½ miles southeast of Middle Haddam, and near the northeast bank of the Connecticut River opposite Haddam village. Two new quarries are located at White Rocks, about 2½ miles east of Middletown.

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[a] For detailed description of the feldspar and quartz deposits of southern New York, see Bull. U. S. Geol. Survey No. 315, 1907, pp. 394–399; also Mineral Resources U. S. for 1906, pp. 1253–1270

The geologic relations of the deposits are not fully known. All of the Connecticut Valley worked deposits occur near the borders of large areas of granite gneiss, mapped by the Connecticut Geological and Natural History Survey as Glastonbury and Haddam granite gneisses, and are probably connected with them in origin. All the deposits are typical granite pegmatites, and form dikelike or sheetlike masses intruding the granite gneisses or neighboring mica schists. The pegmatite mass at the quarry 2¼ miles northeast of South Glastonbury is very regular in form, and consists of a vertical, dikelike mass 20 to 30 feet wide and trending N. 50° E. It is bounded by sharp walls of biotite gneiss. In a small abandoned quarry half a mile southeast of South Glastonbury, the small quantities of mica schist associated with the pegmatite lie nearly flat and the pegmatite mass itself probably occupies a similar attitude. At the Haddam quarry the mica schists which constitute the wall rock stand almost vertical and trend nearly north and south. The pegmatite here, in general, is intruded parallel to the trend of the schist, though occasionally breaking across it. In most of the other localities the structural relations are not clearly shown. In general, as has been found to be the case in other States, the pegmatite masses of this district are more or less lens-shaped, and most commonly are parallel or nearly parallel to the trend of the structures in the bordering rocks.

The form and size of the quarries vary greatly. All are open pits, the largest quarry being located 2 miles south of South Glastonbury, just north of the Middlesex County line. This is a single opening trending in general about N. 15° E. Its total length is about 500 feet, its average width about 100 feet, and its maximum depth about 50 feet. The property has been worked for over forty years, and has yielded an immense quantity of excellent feldspar. Another large quarry is located three-quarters of a mile farther south, in the northern part of the town of Portland, and consists of a lower (northern) pit about 150 feet long, from 30 to 50 feet wide, and 50 feet in maximum depth; and of a southern pit, now in process of excavation, on the same vein at a higher level on the hillside. From these dimensions the sizes of the openings of this district range downward to mere prospect pits.

The feldspar of all these deposits is white to cream-colored potash feldspar (microcline or orthoclase), delicately intergrown with various but relatively minor quantities of soda feldspar (albite). Masses of pure feldspar more than 2 to 3 feet across seldom occur, and most of the material quarried is an irregular intergrowth of feldspar and quartz, or the regular intergrowth known as graphic granite. The latter type, however, is much less abundant than in the feldspar quarries of most other States, and in some quarries appears to be entirely absent. In a few of the quarries graphic granite of exceedingly fine grain occurs, and, as shown on a preceding page, there is reason to believe that this is not notably richer in quartz than the coarse varieties. From most of the quarries only one grade of feldspar is shipped, which would rank commercially as No. 2 or "Standard."

Quartz in commercial quantities does not occur in most of the Connecticut Valley feldspar quarries, and none is shipped. The largest masses observed by the writer were only 3 to 4 feet across. Muscovite is abundant at most of the quarries, and in a few places, as at Haddam Neck, occurs in crystals sometimes 10 inches to 1 foot across and 5 to 8 inches thick. The prevalence of the defects known as "A" structure and "ruling" render most of this material useless except as "scrap" mica to be ground for lubricant, gilding, etc. There is only a limited demand for mica of this type. The principal iron-bearing minerals associated with the feldspar are biotite (brown mica), black tourmaline, and garnets. Where biotite is abundant black tourmaline is usually rare, and vice versa. The biotite crystals are seldom over 5 or 6 inches in length. The black tourmaline also occurs, usually in small crystals, although at the Collins Hill quarry, 2 miles northeast of Portland, some as large as 4 to 5 inches in diameter occur. Garnets are usually small and vary from dark red to black in color. At the Haddam Neck quarry, at the Chatham quarry 1½ miles south of Middle Haddam, and at the Collins Hill quarry occasional cavities or "pockets" in the pegmatite sometimes carry transparent tourmalines of gem quality. Near the pockets the lavender-colored lithium mica (lepidolite) is frequently abundant as aggregates of minute plates. Some of the quarries, one, for example, in the northern part of Portland township 2½ miles south of South Glastonbury, are remarkable for the scarcity of all iron-bearing minerals which can injure the value of the spar.

The quarrying processes are those commonly employed elsewhere, the drilling being done by steam and the rock loosened by blasting, after which it is broken up with sledges and hand sorted. At Haddam Neck the quarry is located close to the Connecticut River, so that the spar may be loaded directly into barges for water shipment. The feldspar from the Collins Hill quarry, 2 miles northeast of Portland, is hauled by team about 2 miles to the Connecticut River and is also shipped by water. The spar from the quarries in the town of Glastonbury is hauled to South Glastonbury, where a part of the product is ground. The ground spar and a part of the crude spar is then ferried across the Connecticut River to Rocky Hill, where it is shipped by rail. The feldspar quarried 2½ miles northeast of South Glastonbury is hauled by team 9 miles to Manchester.

A new feature in the feldspar industry in Connecticut is the completion by the Consolidated Feldspar Company of a feldspar mill at White Rocks, 2½ miles east of Middletown. This mill is equipped with a gyratory crusher, steel crushing rolls, rotary drier, aerial jig screens designed to free the spar from mica, and two continuous-feed tube mills. The capacity of the mill is stated to be from 75 to 100 tons in twenty-four hours. The mill is located within a few rods of the railroad and of the river, so that the material may be shipped either by rail or by water. The quarry is situated at an elevation of about 500 feet on the hill slope above the mill, and the material is carried by aerial tramway direct to the mill, the descending laden carriers hoisting the unladen ones.

Feldspar has in the past been quarried at a number of localities in the western part of the State, in New Haven, Litchfield, and Fairfield counties, but none of these quarries are now operating. Microcline feldspar (potash feldspar) varying from cream to pink in color occurs associated with quartz in the quarry of the Bridgeport Wood Finishing Company near Southford, New Haven County. This quarry is worked only for quartz, which is the predominant mineral, but the feldspar is of excellent quality and occurs in pure masses up to 5 or 6 feet across, and also in coarse graphic intergrowth with quartz. It would probably not pay to work this quarry for feldspar alone, but it would undoubtedly pay to save the latter mineral.

One of the most promising fields for prospecting observed by the writer is the high country 2 or 3 miles east of Middletown, including the prominences known as White Rocks. Feldspar of commercial grade is exposed in a number of rock cuts along the wagon road skirting White Rocks on the north.

### PENNSYLVANIA.[a]

In 1907 Pennsylvania ranked second in the quantity of feldspar produced. The quarries now operated are confined to the southern parts of Delaware and Chester counties, although in the past small quantities of feldspar have been quarried in the southwestern part of Montgomery County. In general character and geologic relations these are similar to the Maryland deposits, and belong to the two distinct types of granite-pegmatite and soda-pegmatite. All of the more important localities were visited by the writer in May, 1907.

*Delaware County.*—The feldspar-bearing pegmatites of Delaware County usually form long and narrow dikelike masses trending in a northeasterly direction. For the most part they are steeply inclined, though the deposit quarried near Elam appears to be rather flat lying. They cut indiscriminately across Wissahickon mica gneiss and the Chester Valley limestone and occasionally cut serpentine. Since the Wissahickon gneiss is the most abundant rock of the region, it forms the wall rock at most of the localities. A number of quarries were formerly worked near Chester Heights, but feldspar is now produced in the county by only one concern, from a quarry 1½ miles south of Brandywine Summit, near Elam. The excavation here covers an area of about 4 acres, and consists of three partly connecting open pits, the eastern two now being abandoned. From the easternmost pit, which is now partially filled with water, much material was excavated by tunneling. The two western pits are much shallower.

The feldspar, which is of the potash varieties, orthoclase and microcline, is cream to flesh colored, and occurs in pure crystals ranging up to slightly more than a foot in diameter. Unlike most quarries yielding potash feldspar, no graphic granite was observed, the quartz usually being irregularly intergrown with the feldspar or the other pegmatite minerals. The quartz is gray in color, and in the present workings seldom occurs in pure masses of any considerable size and is not utilized commercially. According to Hopkins,[a] however, considerable masses of pure quartz were formerly exposed near the bottom of the eastern pit, and future excavations may disclose other quartz masses.

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[a] The feldspar deposits of Pennsylvania were described by T. C. Hopkins in the appendix to the Annual Report of the Pennsylvania State College for 1898-99: Clays and Clay Industries of Pennsylvania, Pt. II.

Muscovite (white mica) occurs both in small crystals and in large plates up to a foot and a half across, but none is of commercial grade. Biotite (black mica) is abundant in certain portions of the pegmatite, in thin, narrow crystals, often several feet long, and wine-red garnets occasionally occur, usually associated with the mica. The mica and garnet-bearing portions of the pegmatite can be readily separated in mining from the areas of purer feldspar.

The deposit seems in general to be rather flat lying. This relation is indicated by the occurrence on the north wall of the eastern pit of about 40 feet of mica schist, beneath which the pegmatite dips apparently at an angle of about 25°. The eastern pit is said to have been excavated to a depth of over 100 feet. In the western pit, which is now being worked, the pegmatite mass is at least 30 feet in thickness, its base not having yet been reached.

The soft weathered material near the surface can be excavated with pick and shovel, but at greater depth steam drilling and blasting are necessary, the material then being hoisted by derrick, loaded into wagons, and hauled about 1½ miles to the mill. Most of the spar is used for pottery purposes, but the cleaner pieces, selected with extreme care, are sold by the barrel for dental purposes. The quarry up to the present time has probably yielded over 150,000 short tons of crude feldspar.

The mill is located on a private spur of the Philadelphia, Baltimore and Washington Railway about a mile southwest of Brandywine Summit station. The process of grinding used here is similar to that used at most other feldspar mills, the material being first crushed by chasers and then ground in tube mills, the principal differences from other mills being in the use of a mechanical carrier for removing the crushed feldspar from the chasers and transferring it to bins over the tube mills, and in the use of large-sized tube mills, instead of the small tube mills usually employed. These are claimed to effect a considerable saving in power. A suction fan is also employed to collect fine feldspar dust, about one bag of this being obtained in the course of a day. This can be marketed for certain purposes, and the device serves to keep the mill much freer from dust than it otherwise would be and to make the work less disagreeable for the men.

Some soda feldspar from a quarry belonging to this company near Nottingham in Chester County is also ground at this mill. The latter variety is burned in a kiln and cooled by a stream of cold water before crushing; this process fractures the spar and renders the crushing and grinding process less difficult. The potash spar is ground just as it comes from the quarry.

*Chester County potash-rich deposits.*—The deposits of potash feldspar worked in Chester County are located near Avondale and Baker, one-half mile northwest of Toughkenamon, three-fourths of a mile northeast of Chatham, 2½ miles north of Pomeroy, and north of Coatesville. In the past they have been quarried at several other points near Avondale and Toughkenamon, at Embreeville, and at a point between

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[a] Ibid, p. 14.

Embreeville and Unionville. Most of these are small producers. One of the largest quarries is that located 2½ miles north of Pomeroy on the property of Mr. B. F. Meredith, the pit now operated being about 150 feet long by 50 feet wide, with smaller connecting openings. Another of the larger quarries worked by the same company is on the property of Mr. Moses B. Carpenter near Toughkenamon. The largest opening here is now abandoned, and only smaller ones are worked. The quarry three-quarters of a mile northeast of Chatham shows an opening about 100 by 80 feet and 40 feet in depth, and several tunnels lead off from the bottom of the pit.

From most of these quarries only one grade of feldspar is shipped. It is principally a graphic intergrowth of quartz with orthoclase, microcline, or both, though in a few of the quarries, notably those near Avondale and Baker, some of the pegmatite has a roughly banded structure, due to the arrangement of the small muscovite plates in irregular and rudely parallel bands. Where this banded structure is present the single crystals of feldspar seldom exceed 2 to 3 inches in greatest dimension, and are often more or less lens-shaped. The only quarry in which masses of pure feldspar of any considerable size were observed was that northeast of Chatham, where the crystals were occasionally a foot or more across. The feldspar forming the larger crystals in the quarry northeast of Chatham is cream-colored potash feldspar (microcline), but associated with this, in intergrowth with the quartz and with some microcline, is white soda feldspar (albite). Some of the latter also occurs intergrown with quartz in the quarries near Baker and Avondale. In all the quarries the soda spar is very subordinate to the potash variety in quantity.

The principal impurities present in the deposits near Baker, Avondale, and Pomeroy are garnet, muscovite (white mica), and occasionally black tourmaline and biotite. At the Chatham quarry biotite is the main impurity. Masses of pure quartz of sufficient size to be of commercial importance are present only in the Chatham quarry.

Like most of the feldspar deposits in other parts of Pennsylvania and Maryland, those of Chester County are much weathered to a depth usually of 10 to 20 feet. The majority of the dikes appear to be nearly vertical or highly inclined, and are intrusive in the highly contorted Wissahickon mica gneiss, the most abundant rock of the region, though they also cut across the Chester Valley limestone. Sometimes, as at the Chatham and Pomeroy quarries, the deposits have very gentle dips. At the Pomeroy quarry the dip in the pit now worked appears to be about 20° to the east. At the Chatham quarry the pegmatite mass is somewhat irregular, but in general lies nearly flat, as are the schists which are the bordering rock at this locality. The width or thickness of the pegmatite masses which are worked varies from 15 to 40 feet. In the early stages of development the weathered surface material can be excavated with a pick and shovel, and after screening and sorting is ready for shipment. In the deeper workings steam drilling and blasting is resorted to, and in the case of the flat-lying deposits north of Pomeroy and near Chatham some tunneling has also been done. At the latter locality the indications are that tunneling will be the only method applicable in the further development of the property, and it remains to be seen whether the cost will be prohibitive.

The potash pegmatites of this region, like those of Delaware County and those of Maryland, appear to be offshoots from the same masses of molten rock which, solidifying under different conditions, formed the granites of this district.

*Soda-rich deposits.*—Pegmatite deposits of the second type are characterized by the dominance of soda feldspar (albite) rather than the potash feldspars (orthoclase and microcline), and are quarried at three points in the extreme southwestern part of Chester County. The westernmost of these quarries is located about 1½ miles west of Sylmar station, Md., but lies in Pennsylvania just north of the State line. The excavation consists of a single pit about 500 feet long, varying from 50 to 150 feet in width, and 80 feet in maximum depth. A second quarry is located a few hundred yards east of this and is about 350 feet long, 150 feet wide, and 80 feet in maximum depth. A third quarry is located about one-half mile north of the two above mentioned. This pit is about 200 feet long, 70 to 80 feet wide, and 90 to 100 feet in maximum depth.

The feldspar at these three quarries is entirely similar in character, as are also the associated minerals. The feldspar is of the soda variety (albite), occurring usually in crystals from 1 inch to 2 inches across, and rarely as much as a foot across. The crude feldspar varies from white through cream to gray; the ground product is pure white.

So far as observed, quartz is entirely absent in the pegmatites of this variety. The principal iron-bearing mineral is hornblende, which is dark green under the microscope, but is nearly black as seen in the quarry. It occurs in aggregates of needle-like crystals, often radially arranged, which occupy spaces between the feldspar grains. Muscovite (white mica) occurs in certain portions of the pegmatite, intergrown with feldspar so as to form more or less rounded aggregates 5 to 6 inches across. The single plates are seldom more than 1½ inches across. Small garnets occur, locally associated with the feldspar. Along some of the structure planes there are thin films of ocher, but these do not materially damage the spar. Some asbestos of the serpentine variety and some talc occur along contacts between the feldspar masses and the wall rock, but they are not present in commercial quantities.

The soda-pegmatite masses are all highly inclined. The westernmost quarry taps two veins, both trending about northwest and southeast, but possessing somewhat different dips, one being approximately vertical, while the other is inclined so that it joins the first near the bottom of the quarry and forms a single vein. The pegmatite mass at the eastern quarry also trends northeast and southwest, and is about in line with that at the western one; it may be a continuation of the same body. The pegmatite mass quarried about one-half mile to the north of these quarries is about 12 feet wide. Its south end is nearly vertical and trends about N. 10° W. It is probable that all of these deposits continue to a greater depth than that reached by the present workings and that they may also be traced farther in the direction of their trend. All of them are intrusive in serpentine rock, and the development of talc and fibrous serpentine near the contact between the pegmatite and the wall rock is probably due in part at least to the contact metamorphic effects of the pegmatite.

These deposits are worked by steam drills and blasting, and steam hoists are used in handling the material. The feldspar from two of these quarries is hauled by teams about 2 miles to the railroad near Sylmar and shipped in the crude state. The product of the other quarry is ground at a mill near the quarry, the ground spar being hauled to Sylmar for shipment. The spar before grinding is burned in a continuous kiln, which has the effect of fracturing it and facilitating the grinding process. It is then crushed in chaser mills and transferred to tube mills for grinding. Two types of the latter are in use—the ordinary small tube mill used in most feldspar mills, capable of holding a load of about 3 tons, and a larger tube mill capable of grinding 5 or 6 tons at a charge. It is claimed that the larger mill is more economical. The one here used was originally of the continuous feed type, but was later converted into an intermittent mill.

The better grades of feldspar, containing little or none of the iron-bearing minerals, are ground to the usual fineness for pottery purposes, but material containing some hornblende is less finely ground and is marketed for glass-making purposes, the presence of small quantities of iron-bearing minerals not being detrimental for this utilization. Practically the whole of the pegmatite mass can be utilized. The crude soda spar shipped from this vicinity is usually mixed with potash spar from other localities before grinding, so as to make a "harder" (less fusible) product.

### MARYLAND.

The State of Maryland ranks fifth in quantity in the list of feldspar producers. The active quarries are confined to Howard, Baltimore, and Cecil counties. All of the more important quarries were visited by the writer in May, 1907, and a few were revisited in April, 1908. The bulk of the spar quarried is ground either at Trenton, N. J., or at Wilmington, Del. A small part of the output is ground at a small mill in Baltimore, the only feldspar mill within the State.

*Howard and Baltimore counties.*—The most productive deposits of commercial quality occur along the Patapsco River in the southwestern part of Baltimore County, and in adjacent parts of Howard County. The principal quarries are near Woodstock in Howard County and near Granite and Hollofield in Baltimore County. The majority are small workings, producing less than 1,000 tons each per year. The quarry on the Frost farm, 1 mile southeast of Woodstock, is the largest producer.

The feldspar occurs as a constituent of pegmatite masses within an area occupied mainly by the Baltimore mica gneiss and by areas of intrusive granite and basic igneous rocks (gabbro and serpentine). Most of the workings near Woodstock are too shallow, too much weathered, and too limited in extent to show clearly the trend and dimensions of the deposits, but in common with most pegmatite masses they are for the most part long veinlike or sheetlike masses, usually lying parallel to the general trend of the surrounding schists, though occasionally breaking across their trend. The schists are highly crumpled. The feldspar deposit worked on the property of Mr. C. H. Johnson, about one-half mile southeast of Woodstock, on the Baltimore County side of the river, is flat-lying, several masses of pegmatite being separated by nearly horizontal layers of rotten schist. At the Fagan quarry, in Baltimore County, about one-half mile south of Hollofield, the principal feldspar mass seems to trend northeast and southwest, parallel to the trend of the bordering schists. Another feldspar mass opened near the last mentioned appears to be flat-lying.

At most of the quarries in Baltimore and Howard counties the most abundant feldspar is of the potash variety, though with it is usually associated some soda feldspar. At the Frost quarry, near Woodstock, the latter appears to be more abundant than the potash feldspar. The feldspar at the quarry on the C. H. Johnson place (Baltimore County), one-half mile southeast of Woodstock station, is flesh-colored orthoclase, which occasionally shows a bluish tint. That quarried one-fourth mile east of the Johnson quarry is mostly flesh-colored microcline, though some of the finer-grained portions, more abundantly associated with quartz and mica, are white albite. The feldspar at the Fagan quarry in Baltimore County, one-half mile south of Hollofield, is in part a light-pink microcline; but with this, in intergrowth with light-gray quartz, occur subordinate quantities of the white soda feldspar (albite). In few of the quarries do the crystals of pure potash feldspar exceed a foot in diameter, but at the quarry three-fourths mile east of Woodstock a small number of crystals 3 to 5 feet across were observed.

The principal mineral associated with the feldspar in these deposits is quartz, but it is usually intimately intergrown with the feldspar, and only at the quarry three-fourths of a mile east of Woodstock does it occur in masses large enough to be commercially valuable. At the time of the writer's visit a mass of pure quartz 4 by 10 feet was exposed on the wall of this quarry. The principal iron-bearing mineral occurring in these pegmatites is black mica (biotite), usually in quite small plates, which occasionally are so abundant as to render the feldspar worthless for pottery purposes. Muscovite (white mica) is also present in most of the quarries, but is in small plates—too small to be of commercial value, and usually not sufficiently abundant to injure the value of much of the feldspar. At the Fagan quarry, one-half mile south of Hollofield, muscovite is mainly in graphic intergrowth with quartz and with feldspar. Small quantities of black tourmaline also occur at the latter quarry in crystals up to 1½ inches in diameter, and must be carefully separated.

Most of the feldspar deposits of this region are much decayed at the surface, and until some depth has been reached in the excavation little or no blasting is necessary, the material usually being excavated with the aid only of pick and shovel. It is then sorted by hand, and loaded upon wagons for haulage to the nearest railroad point. At one quarry near Woodstock the material is less decayed, and steam drilling and blasting are necessary in excavation. The feldspar quarried here is carried by a chute directly from the quarry to the railroad cars. Most of the quarries are within a mile of the railroad, and many of them are located along the valley slopes of the Patapsco River, so that the material can be easily handled by gravity.

The largest feldspar quarry in this district is located in a pegmatite deposit of a somewhat different character from those described above. It is situated on the Frost farm, about one-half mile south-southwest of Davis station, near Woodstock, Howard County, and is operated for Goldings Sons' Company, of Trenton, N. J., by Mr. John Mitchell. In April, 1908, this quarry was about 450 feet long by 100 wide by 65 in maximum depth, its greatest dimension trending about N. 60° E. The feldspar is of two varieties: (1) orthoclase and microcline varying from light gray to pale flesh-colored, and (2) white to gray soda feldspar (albite). The potash feldspar occurs occasionally in pure crystals as much as 4 feet across, and sometimes occurs in graphic or dendritic intergrowths with gray quartz. The soda feldspar is equal to if not greater than the potash feldspar in quantity, but occurs in smaller crystals, which are seldom over a few inches in diameter. The largest observed is about 1 foot across. Black mica (biotite) is entirely absent and white mica (muscovite) occurs only rarely and in plates less than an inch across. Quartz does not occur in large masses but is mostly intergrown with feldspar. The principal iron-bearing impurity is green hornblende, which occurs in prismatic crystals up to 1 foot in length. Pyrrhotite also occurs in small quantities, usually with the hornblende. It will be noted that in mineral character this pegmatite is intermediate between the two types previously mentioned. The abundance of albite feldspar, the presence of hornblende, and the scarcity of mica relate it to the deposits of soda spar worked near Sylmar, in southwestern Chester County, Pa., while the presence of quartz and of potash feldspar, sometimes graphically intergrown, relate it to the typical granite pegmatites.

In this quarry a steam drill is used and a derrick is operated by a hoisting engine. The material is hauled about a quarter of a mile to the railroad and is shipped to Trenton, N. J., and Wilmington, Del.

*Cecil County.*[a]—The second feldspar district of Maryland is in the northwestern part of Cecil County. Only two firms are now operating in this locality, and these are quarrying talc as well as feldspar. A number of small quarries were opened in 1906 at Bald Friar, 1½ miles north of Conowingo. Talc is the principal output at this locality, and is ground at a mill near the quarries. Feldspar is a secondary product, and is all shipped in the crude state. The quarries in May, 1907, consisted of a number of small pits along the upper part of the bluffs bordering the Susquehanna River. The feldspar when fresh is snowy white, and is of the soda variety (albite). Near the surface where the material is weathered to some extent there is a slight iron discoloration along the fractures, but this is not sufficient to damage materially the quality of the product. The veins range up to 15 feet in width, and show frequent pinchings and swellings. They occur as intrusions in an area of rocks which are mapped on the Cecil County sheet of the Maryland Geological Survey as serpentine, peridotite, and pyroxenite. The surrounding rocks have been altered locally to form talc schists, and in some cases there seems to have been some further alteration due to contact metamorphism by the feldspar masses, as suggested by an unusual abundance of pyrite near the pegmatite and by the development there of narrow zones of fibrous serpentine (asbestos). These pegmatite masses seem to be entirely free from quartz, and their feldspar, so far as observed, is all of the soda variety (albite). Mica and other injurious minerals are rare or entirely absent.

The location of these quarries on the valley slope facilitates the handling of the material, which is carried down by chutes to the flats near the railroad and the river. The quantity of material is probably not sufficient to warrant mining for feldspar alone, but the feldspar forms an important adjunct in the quarrying of talc.

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[a] The pegmatite deposits of Cecil County are briefly described in the report on Cecil County by the Maryland Geological Survey, 1902.

In the spring of 1907 a small quarry was opened by the Verona Mining Company at Rock Springs, about 3½ miles northeast of Conowingo. The material here is almost exactly similar in character and mode of occurrence to that just described from Bald Friar, and occurs within the same belt of basic rocks (serpentine, pyroxenite, etc.). Talc is also obtained at this quarry. The spar is hauled by team 3 miles to Conowingo, and there shipped by rail. Feldspar has been quarried in the past at other points in the vicinity of Rock Springs and along Octoraro Creek.

As will be seen from the foregoing descriptions, most of the feldspar deposits worked in the Woodstock region belong to the class of potash-rich or granite pegmatites already mentioned, while the deposits worked in Cecil County, like those just across the line in Chester County, Pa., belong to the soda-rich type. The deposit worked on the Frost farm near Woodstock is intermediate between these two types in character.

The only new features of note in the Maryland industry besides those already mentioned is the opening of a small quarry near Hollofield and of another 2 miles northeast of Granite, in Baltimore County. The latter is operated by the Eureka Mining and Operating Company, and is closely adjacent to a quarry worked many years ago by Goldings Sons' Company. It may tap the same pegmatite body. Like most of the deposits worked near Woodstock, it belongs to the granite pegmatite type. Its principal constituents are orthoclase feldspar, quartz, black mica (biotite), and some soda feldspar (albite). No large crystals were seen.

## WISCONSIN.

The feldspar deposits of Wisconsin are as yet undeveloped. Pegmatite deposits containing feldspar are known to occur in the town of Stettin, Marathon County, about 4 miles northwest of Wausau. They occur as pegmatite dikes cutting granite (quartz syenite), and are very abundant over an area 5 or 6 square miles in extent in the central part of this township. The dikes vary in width from 1 foot to 20 feet, and are said to be so abundant locally as to be nearly equal in quantity to the masses of granite lying between them. The principal constituents of the pegmatite dikes are feldspar and quartz, with subordinate quantities of white mica (muscovite) and of the iron-bearing minerals black mica (biotite), hornblende, pyroxene, and other minerals. The feldspar is mostly a fine-grained (microperthitic) intergrowth of potash feldspar and soda feldspar, and contains soda in nearly as large percentages as potash. It is therefore intermediate in composition between most of the so-called "hard" or potash feldspars mined in Canada and the eastern United States, and the typical "soft" or soda feldspars such as are mined in Chester County, Pa. The crystals of pure feldspar range from about an inch to somewhat over a foot in diameter. The size of the dikes is not so great as of most of those worked in the Eastern States, but they may prove of commercial value if the iron-bearing minerals are not so abundant or so distributed as to injure much of the feldspar.

These deposits are situated within about 8 miles of the railroad at Wausau, and within about 5 miles of the railroad station at Marathon, and seem worthy of investigation from a commercial standpoint.

### VIRGINIA.

During 1907, potash feldspar was produced at three quarries in Virginia and shipped crude to Trenton, N. J. Two of these quarries are new developments, and are located near Bells, in Bedford County, and near Prospect, in Prince Edward County. A third quarry is located near Amelia, in Amelia County. None of these have yet been visited by the writer.

### TEXAS.

A deposit of pink potash feldspar, apparently of excellent quality, is known to occur at Barranger Hill, in Llano County. The pegmatite here has been worked for its rare-earth minerals, but no attempt has been made to utilize the feldspar and quartz. Its character is described more fully in the report on quartz and feldspar in the Mineral Resources of the United States for 1906.

### MINNESOTA.

A considerable quantity of lime-soda feldspar or plagioclase, varying in composition from labradorite to bytownite, is quarried in Lake County and ground at Duluth by two firms. The material is used mainly for abrasive purposes, filter beds, etc., although a small quantity is used in pottery manufacture.

## PRODUCTION.

In the following table the material is entered as "Crude" or "Ground" according to the condition in which it was first placed on the market. Practically the whole production is eventually crushed or ground.

The production of feldspar in 1907, exclusive of that used for abrasive purposes, amounted to 31,080 short tons of crude feldspar, valued at $101,816, and 53,469 short tons of ground feldspar, valued at $397,253, a total of 84,549 short tons, valued at $499,069. The State totals are given in the following table:

*Production of feldspar in 1907, in short tons.*

| State. | Crude. | | Ground. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Maine | 45 | $110 | 16,428 | $157,224 | 16,473 | $157,334 |
| New York | 3,909 | 15,825 | 11,500 | 40,500 | 15,409 | 56,325 |
| Connecticut | 10,663 | 28,433 | 8,380 | 51,770 | 19,043 | 80,203 |
| Pennsylvania | 7,367 | 28,169 | 12,266 | 108,678 | 19,633 | 136,847 |
| Maryland | 7,169 | 23,672 | 3,895 | 34,081 | 11,064 | 57,753 |
| Other States | 1,927 | 5,607 | 1,000 | 5,000 | 2,927 | 10,607 |
| Total | 31,080 | 101,816 | 53,469 | 397,253 | 84,549 | 499,069 |

The production of feldspar from 1902 to 1907 is given in the following table:

*Production of feldspar, 1902–1907, in short tons.*

| Year. | Crude. | | Ground. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1902 | 21,870 | $55,501 | 23,417 | $194,923 | 45,287 | $250,424 |
| 1903 | 13,432 | 51,036 | 28,459 | 205,697 | 41,891 | 256,733 |
| 1904 | 19,413 | 66,714 | 25,775 | 199,612 | 45,188 | 266,326 |
| 1905 | 14,517 | 57,976 | 20,902 | 168,181 | 35,419 | 226,157 |
| 1906 | 39,976 | 132,643 | 32,680 | 268,888 | 72,656 | 401,531 |
| 1907 | 31,080 | 101,816 | 53,469 | 397,253 | 84,549 | 499,069 |

The increase in the figures of production for the year 1907 over those reported for 1906 is due in part to increasing completeness in the Survey's list of feldspar producers, but in the main it means an actual increase in production through the development of new properties and an increase in the output of properties already developed, especially among the small producers. This growth was felt in nearly all of the feldspar-producing States, but was checked in the fall by the financial panic. Up to the time of the panic the market conditions were reported to be good.

The total production of feldspar in 1907, including abrasive feldspar, amounted to 91,799 short tons, valued at $558,944.

## GRADES AND PRICES.

Most dealers recognize three grades of commercial feldspar: No. 1, No. 2 (sometimes called "Standard"), and No. 3. From quarries in granite pegmatite, where the spar is mostly of the potash variety, these are usually graded as follows: No. 1 is carefully selected, free from iron-bearing minerals, largely free from muscovite, and contains little or no quartz, usually less than 5 per cent; No. 2 is largely free from iron-bearing minerals and muscovite, but usually contains when ground from 15 to 20 per cent of quartz; No. 3 is not carefully selected and contains somewhat higher percentages of quartz, muscovite, and iron-bearing minerals. Spar from the soda pegmatites of southeastern Pennsylvania and adjacent parts of Maryland, being wholly free from quartz, is graded entirely on the basis of its freedom from iron-bearing minerals, principally hornblende. No. 1 is carefully selected and is practically free from such impurities; No. 2, though less carefully selected, is still fairly free from them; No. 3 is not carefully selected and carries hornblende in large enough quantities to render it unfit for use in pottery manufacture. It is utilized principally in glass manufacture. Crushed pegmatite from New York State, used for poultry grit and for coverings for surfaces to give them the appearance of granite, and feldspar from Minnesota used mainly for abrasive purposes, are graded according to coarseness.

The prices of feldspar during 1907, so far as data are available, were about as follows: The "Standard," or No. 2 spar, which constituted the great bulk of the feldspar used in the pottery trade, brought in the crude state in Maine from $2.50 to $3 per long ton, free on board nearest shipping point to quarries; in New York from $4 to $5; in Pennsylvania from $3.50 to $4.50, and in Maryland from

$3.50 to $4. Crude No. 1 feldspar usually brings from 50 cents to $1.50 more per ton than No. 2, and crude No. 3 brings about the same amount less.

The prices for No. 2 or "Standard" spar, ground to the fineness usually demanded in the pottery industry, ranges in most cases from $7 to $10 per short ton, free on board nearest shipping point to the mills. No. 1 brings from $2 to $4 more per ton. With finer grinding, such as is demanded by some scouring soap manufacturers, the prices are proportionally higher.

Very pure, carefully selected potash feldspar, for use in the manufacture of artificial teeth, usually sells at from $6 to $8 per barrel of 350 pounds.

# TALC AND SOAPSTONE.

## INTRODUCTION.

Talc and soapstone are found in nearly all the Atlantic slope States, and in many of them the deposits are so favorably located as regards transportation and markets as to make their development profitable. During 1906 and 1907 such quarries were operated in Georgia, North Carolina, Virginia, Maryland, Pennsylvania, New York, New Jersey, Rhode Island, Massachusetts, and Vermont. New York, which formerly enjoyed the distinction of being the largest producer of talc in the United States, was in 1906 and 1907 surpassed as to value by Virginia, whose product represents about 41 per cent of the total value.

Deposits of talc and soapstone occur in several of the Western States also, but the conditions as regards transportation and markets are not favorable enough at the present time to justify development, since the industries in which these minerals would be used have not yet been established.

Small quantities of talc were quarried in California and Washington during 1904 and 1905, but no production was reported from either State in 1906, nor any from Washington in 1907.

The product of the quarries varies from pure foliated talc to harder steatite or soapstone. For use in the arts it is either powdered or sawed into slabs or manufactured into various articles. The powdered or flour talc is used in the manufacture of a great variety of articles, such as fireproof paints, electric insulators, covering for steam pipes, foundry facings, dynamite, paper, toilet powder, leather lubricators, and soap. The soapstone, not powdered, is used in the manufacture of hearthstones, furnace linings, laboratory tables, laundry tubs, ovens, foot warmers, and many other articles of everyday use. Some of the purer varieties are manufactured into pencils and gas tips, the talc suitable for this purpose bringing a higher price than any other produced in this country.

## PRODUCTION.

Including the production of fibrous talc, most of which is quarried at Gouverneur, St. Lawrence County, N. Y., the total output of talc and soapstone in the United States in 1907 amounted to 139,810 short tons, valued at $1,531,047, an increase, as compared with 1906, of 19,166 short tons, or 15.9 per cent, in quantity, and of $99,491, or 7 per cent, in value. The increased production in 1907 was distributed among all the new important producing States.

The smaller percentage of increase in value was not due to any general decline in price, but to a larger proportion of the product which was sold in the crude or unmanufactured state, and in this portion of the product there was a decline in price. By far the larger number of the talc and soapstone quarries are operated or controlled by the manufacturers, and only a comparatively small part of the output is sold in the crude state. In 1907, however, there was an unusually large quantity sold crude, and part of this was low-grade material. The quantity sold crude in 1906 was 15,211 short tons, having an average value per ton of $2.65. In 1907 the marketed production of rough or unmanufactured soapstone was 25,538 tons, at an average price per ton of $1.36, so that while the quantity sold exhibited a gain of 10,327 short tons, or about 66 per cent, the total value decreased $5,712. The average price for ground soapstone was the same in 1907 as in 1906, while prices for manufactured articles or partially manufactured materials were higher.

The talc and soapstone production is classified in the following four groups: Rough or crude, sawed into slabs, manufactured articles, and ground. A part of the crude product, represented in the first group, is sold to factories, and some of this is probably again included in the estimates of manufactured articles or ground materials represented in the other three groups, though duplication is avoided if possible. The relative quantities and values of these varieties produced in the United States during the last four years are shown in the following table:

*Production of talc and soapstone in the United States, according to varieties, 1904–1907.*

| Condition in which marketed. | 1904. | | | 1905. | | |
|---|---|---|---|---|---|---|
| | Quantity (short tons). | Value. | Average price per ton. | Quantity (short tons). | Value. | Average price per ton. |
| Rough | 1,815 | $9,270 | $5.11 | 1,625 | $10,483 | $6.45 |
| Sawed into slabs | 3,850 | 64,276 | 16.70 | 4,779 | 80,879 | 16.92 |
| Manufactured articles[a] | 11,990 | 283,373 | 23.63 | 14,665 | 403,660 | 27.53 |
| Ground[b] | 73,534 | 583,812 | 7.94 | 75,565 | 587,040 | 7.77 |
| Total[c] | 91,189 | 940,731 | 10.32 | 96,634 | 1,082,062 | 11.20 |

| Condition in which marketed. | 1906. | | | 1907. | | |
|---|---|---|---|---|---|---|
| | Quantity (short tons). | Value. | Average price per ton. | Quantity (short tons). | Value | Average price per ton. |
| Rough | 15,211 | $40,337 | $2.65 | 25,538 | $34,625 | $1.36 |
| Sawed into slabs | 4,980 | 83,563 | 16.78 | 4,822 | 91,668 | 19.01 |
| Manufactured articles[a] | 23,575 | 631,342 | 26.78 | 23,484 | 648,475 | 27.61 |
| Ground[b] | 76,878 | 676,314 | 8.80 | 85,966 | 756,279 | 8.80 |
| Total[c] | 120,644 | 1,431,556 | 11.87 | 139,810 | 1,531,047 | 10.95 |

[a] Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks, griddles, slate pencils, tailor's pencils, gas tips, burner blanks, crayons, and numerous other articles for everyday use.

[b] For foundry facings, paper making, lubricators for dressing skins and leather, etc.

[c] Exclusive of the quantity used for pigment, which is included among mineral paints.

The total production of talc and soapstone in the various States in 1905, 1906, and 1907 is shown in the following table. In cases where the whole production of a State is limited to the operations of one or two quarries, the statistics are combined with one or more other States in order that information regarding individual establishments may not be divulged. As shown by this table, New York produces the largest quantity, nearly all of the fibrous variety, while Virginia, second in quantity, ranks first in the value of the product, because of the advanced state of manufacture in which the output is sold.

*Production of talc and soapstone, 1905, 1906, 1907, by States, in short tons.*

| State. | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Georgia | (a) | (a) | (a) | (a) | 739 | $11,473 |
| Maryland | (a) | (a) | 2,956 | $23,310 | 5,064 | 32,250 |
| New Jersey and Pennsylvania | 5,796 | $38,241 | 13,981 | 52,961 | 17,103 | 46,871 |
| New York | 56,500 | 445,000 | 61,672 | 557,200 | 67,800 | 626,000 |
| North Carolina | 4,035 | 74,690 | 4,009 | 66,729 | 4,085 | 74,347 |
| Vermont | 8,978 | 65,525 | 10,413 | 101,057 | 16,200 | 82,500 |
| Virginia | 17,665 | 425,090 | 23,624 | 590,800 | 26,278 | 631,880 |
| Other States [b] | 3,660 | 33,516 | 3,989 | 39,499 | 2,541 | 25,726 |
| Total | 96,634 | 1,082,062 | 120,644 | 1,431,556 | 139,810 | 1,531,047 |

[a] Included in "Other States."

[b] California, Georgia, Maryland, Massachusetts, and Washington in 1905; Georgia, Massachusetts, and Rhode Island in 1906; California, Massachusetts, and Rhode Island in 1907.

## PRODUCTION OF FIBROUS TALC IN NEW YORK.

Practically all of the fibrous variety of talc produced in the United States comes from the vicinity of Gouverneur, St. Lawrence County, N. Y. It is all ground and is used principally for filling in the manufacture of medium grades of paper, though some goes into the paint trade, and some is used in the preparation of wall plasters, for which its fibrous character and heat-resisting quality make it well adapted. The production of fibrous talc in New York from 1904 to 1907, inclusive, is shown in the following table:

*Production of fibrous talc in New York, 1904–1907, in short tons.*

| Use. | 1904. | | 1905. | | 1906. | | 1907. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Paper filling<br>Paint<br>Wall plasters | 64,005 | $507,400 | 56,500 | $445,000 | 61,672 | $557,200 | 67,800 | $626,000 |

## TOTAL PRODUCTION.

The quantity and value of talc and soapstone products from New York, as compared with the total from all other States since 1880 and to the close of 1907, are shown on the following table. From this it appears that in the twenty-eight years from 1880 to 1907, inclusive, the period covered by the volumes of Mineral Resources, the total production of talc and soapstone has amounted to 1,700,903 short tons, valued at $19,099,103. Of this total New York has contributed about 50 per cent of the value.

*Production of talc and soapstone in the United States, 1880–1907, in short tons.*

| Year. | New York. | | All other States. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1880–1900 | 629,925 | $5,933,501 | 340,003 | $5,291,151 | 969,928 | $11,224,652 |
| 1901 | 69,200 | 483,600 | 28,643 | 424,888 | 97,843 | 908,488 |
| 1902 | 71,100 | 615,350 | 26,854 | 525,157 | 97,954 | 1,140,507 |
| 1903 | 60,230 | 421,600 | 26,671 | 418,460 | 86,901 | 840,060 |
| 1904 | 64,005 | 507,400 | 27,184 | 433,331 | 91,189 | 940,731 |
| 1905 | 56,500 | 445,000 | 40,134 | 637,062 | 96,634 | 1,082,062 |
| 1906 | 61,672 | 557,200 | 58,972 | 874,356 | 120,644 | 1,431,556 |
| 1907 | 67,800 | 626,000 | 72,010 | 905,047 | 139,810 | 1,531,047 |
| Total | 1,080,432 | 9,589,651 | 620,471 | 9,509,452 | 1,700,903 | 19,099,103 |

## IMPORTS.

The imports of talc into the United States have never been large, though the prices obtained are usually somewhat higher than the averages shown for the American product, and the values quoted for the foreign material are at point of shipment and are exclusive of freight and duty. The reason for these higher values may be attributed to the fact that only the fancy grades, which are used for the manufacture of face powder and for medicinal purposes, are imported into this country. The imports in 1907 showed an increase of nearly 50 per cent, both in quantity and value, over 1906.

*Talc imported into the United States, 1902–1907, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity | Value. |
|---|---:|---:|---|---:|---:|
| 1902 | 2,859 | $35,366 | 1905 | 4,000 | $48,225 |
| 1903 | 1,791 | 19,677 | 1906 | 5,643 | 67,818 |
| 1904 | 3,268 | 36,370 | 1907 | 10,060 | 126,391 |

## CANADIAN PRODUCTION.

There has been a small production of talc in Canada for several years, but the tonnage and values have varied considerably. In 1907 the production amounted to 1,534 short tons, an increase of nearly 25 per cent over that of 1906, which in turn was more than double than that of 1905. The Canadian Geological Survey reports the production of talc in the Dominion for the last six years as follows:

*Production of talc in Canada, 1902–1907, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---:|---:|---|---:|---:|
| 1902 | 689 | $1,804 | 1905 | 500 | $1,800 |
| 1903 | 688 | 2,064 | 1906 | 1,234 | 3,030 |
| 1904 | 840 | 1,875 | 1907 | 1,534 | 4,602 |

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